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THE EFFECTIVENESS OF ERGONOMIC TRAINING ON VISUAL DISPLAY TERMINAL OPERATORS

Degree of Master in Science (Medicine) in Biomedical Science

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ABSTRACT

This study was conducted in order to evaluate the effectiveness of a "self-help" ergonomics-training program, which was instituted in order to reduce the risk of musculoskeletal disorders and eyestrain in video display terminal (VDT) operators.

An ergonomic assessment and a "symptom survey" of forty-eight (48) VDT workstations was undertaken by the researcher, before and after intervention. This ergonomic survey was done in order to ascertain the type and severity of the health complaints associated with VDT workstations and to measure the changes in the workstations made by the VDT operators after intervention.

Twenty-five (25) operators were randomly allocated to the experimental group and received ergonomic training in self-help skills and twenty-three (23) were randomly allocated to the control group, which did not receive training.

The ergonomic assessment of the workstations concluded that there was inadequate workstation design and the "symptom survey" confirmed a high incidence of musculoskeletal disorders that could be related to the poorly designed workstations.

The experimental group did not make significantly more changes than the control group but the changes made by the control group were not as a result of training but rather random changes in the organization of the work environment which were beyond the control of the operator. There was a significant correlation between the number of ergonomic problems in the workstation and the number of changes made after training which supports the hypothesis that when workers are given training and motivated by a poor working environment they will make whatever changes they are empowered to make.

Although the number of pain sites in the control group decreased more than in the experimental group there was a significantly larger reduction in the mean pain rating of the experimental group versus the control group. Further research over a longer period of time is needed to ascertain the long-term reduction in musculoskeletal disorders (MSDs).

FOREWORD

Glossary of technical terms

Ergonomics: is the "science of worker-workplace interaction". Ergonomics is applied in industry in order to reduce injuries and errors and improve job performance.

Anthropometry: measurement of the human body

Cumulative Trauma Disorder or Repetitive Strain Injury: is a term used to describe a collection of musculoskeletal disorders, e.g. carpal tunnel syndrome, low back pain, tendonitis, tenosynovitis, epicondylitis etc., that are work-related and associated with repeated or cumulative exposure to ergonomic stressors/hazards. The most distinguishable symptoms are pain, numbness and tingling, restriction of joint movement and soft tissue swelling.

Carpal tunnel syndrome (CTS): is a common condition affecting the wrist and hand and is caused by increased pressure on the tendons and nerves in the carpal tunnel (a narrow opening in the wrist). CTS can result from working with the wrists held in extreme postures.

"Ergonomic Hazards": factors in the workplace that contribute to musculoskeletal disorders, e.g. repetitive motion, posture, vibration, and workplace conditions that pose a risk of injury or illness. Ergonomic hazards may also arise from poor job designs and organizational factors, e.g. excessive work duration, lack of work variety and limited workstation space.

Repetition: a sequence of motions or tasks that are performed over and over again with little variation. When these motions are repeated frequently (every few seconds), fatigue sets in and muscle and tendon strain accumulates which can cause permanent tissue damage.

Posture: when employees work in awkward postures more muscular force is required to maintain the posture, as muscles are not working efficiently. If the postures are static this will lead to early muscle and tendon fatigue.

Occupational Risk Factors for Musculoskeletal Injuries

Repetitive exertions: low level exertions that are repeated frequently such as Video Display Terminal (VDT) keyboard entry tasks, repetitive motions of small body segments e.g. finger and hand motions used in fast keying operations

Awkward/Static postures: working with the trunk bent forward, backward or twisted can place stress on the neck and back. For example working with the wrist extended, flexed or with ulnar or radial deviation is a risk for wrist injury.

Mechanical stresses: are created when the soft tissue is squeezed between a bone and an object in the work environment e.g. when the wrist is rested against the sharp edge of the work surface whilst typing.

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THE EFFECTIVENESS OF ERGONOMIC TRAINING ON VISUAL DISPLAY TERMINAL OPERATORS: Warner-Lambert SA (PTY) LTD

1 INTRODUCTION

Pfizer is a large international corporation with eighty-five manufacturing plants worldwide, Warner-Lambert is part of the Pfizer corporate structure. We here at Warner-Lambert, Cape Town are part of a larger worldwide network of companies and have to adhere to the Corporate requirements which are set in the United States of America. Part of the requirements of the Health Safety and Environmental department relates to ongoing training programs. In order to ensure that those requirements are attainable locally, research needs to be conducted to ascertain the effectiveness of training programs in South Africa in order that we can adapt these programs to our unique circumstances.

Warner-Lambert has made a commitment to their colleagues (workers) to provide an environment where people can be innovative and excel. They are committed to retaining their workers and providing them with an open and participative work environment with equal opportunities for personal growth. Colleagues are encouraged to share responsibility for continuously improving the performance of the company and the quality of the work life.

As part of this commitment, management received a directive from head office in New York requesting that an ergonomic survey be done to proactively diagnose deficiencies in the workplace that could result in occupation related musculoskeletal disorders and to make recommendations where necessary for ergonomic solutions. Occupational musculoskeletal injuries are being recognized globally for the damage that they do both to the employee and the employer. This has resulted in many different prevention strategies, which need to be critically evaluated for efficacy.

Due to the high incidence of complaints of musculoskeletal disorders and visual fatigue suffered by Video Display Terminal (VDT) operators it was decided by management to formulate an ergonomics program to improve the ergonomics of VDT workstations (Appendix 1). An initial ergonomic survey of forty-eight (48) workstations was conducted:

1.1 To evaluate the existing workstations

1.2 To establish the existence of a link between poor ergonomically designed workstations and musculoskeletal complaints of the operators

1.3 To make recommendations for the improvement of VDT workstations.

In the light of the above mentioned factors it was decided to make changes to the existing conditions of VDT operators workstations. Operators themselves were given training so that they themselves could assess the ergonomics of their workstations and make the necessary ergonomic changes taking into account their unique work setting. In this way optimal conditions could be established and maintained.

Twenty-five (25) operators were trained in self-help skills to enable them to make the necessary ergonomic changes within their workstations. The success of the program would be gauged by comparing the changes made by the operators who had received training with the changes (if any) made by the control group.

If the results showed that those operators who had received training made significantly more ergonomically motivated (correct) changes and that as a direct consequence thereof these operators showed a reduction in the number of musculoskeletal and eyestrain complaints, then it would be beneficial for the company to introduce mandatory training for all VDT operators. If there was no significant improvement in the number of musculoskeletal disorders then other ways of improving the ergonomics of the workplace should be sought.

1.1 PLANNING THE OFFICE OF TOMORROW - TODAY

The motivation for increased automation is to improve efficiency and productivity and thereby improve profitability. However unless new electronic systems are well integrated into the workplace there will be no improvement in profitability and productivity.

Corell (1984) stated that "office electronics" is the driving force for change in modern offices, but it is neither the source nor the solution to office problems. Successful intervention must adopt a multifaceted approach taking into account the four basic office elements of: technology, facilities, job function and people. The increase in office and communications technology will result in more computers and other hardware being placed directly into the workstation. Existing buildings are increasingly not able to support the escalating demands of automation, which include lighting, wiring, heating, cooling and privacy. Due to the increasing automation of tasks, job functions must be redesigned to make better use of the worker's capabilities and reduce boredom. Employers need to view workers as valuable assets. This can be achieved in part by recognizing the importance of health and safety issues. Employees need training to maximize the benefits of change. Employees will only make ergonomic changes when they are convinced as to why the changes are worthwhile.

The technological revolution offers challenges and opportunities to improve worker efficiency. In order to achieve these goals, Corell (1984) stated that certain conditions must be met: there must be a strong commitment from management, backed by the organizational, motivational and economic resources necessary for successful intervention. Throughout this process there should be ongoing consultations with the workers. A team of experts should be involved in assessing workstations, making recommendations and training workers.

2 DEFINITION OF THE PROBLEM

Luopajarvi (1987) stated that health education was one of the most important weapons against work-related musculoskeletal disorders. The scope of health education as a preventative occupational health measure has expanded since 1954 when the WHO committee defined the aims of health education as follows:

2.1 To make health a valuable community asset

2.2 To give individuals and communities the knowledge and skills they need to solve their own health problems

2.3 To promote the proper use and development of health services

Health education is usually based on the model of recognizing health problems and the treatment and prevention of diseases. It has been acknowledged that in industrial countries many people have the knowledge about health matters but fail to follow good medical practices in everyday life. It is therefore important to evaluate the effectiveness of health education.

In recent years there has been a significant increase in the reporting of musculoskeletal disorders (MSDs) and other work-related disorders due to poor ergonomic layout of workstations. MSDs account for an increasingly large percentage of worker's compensation costs. According to the United States Bureau of Labour Statistics (1995) 62% of all occupational illness cases were due to disorders associated with repeated trauma resulting in MSDs. A reason for this high percentage can be due to changes in technology that expose the workers to increased repetitive motion and also to increased awareness and reporting of disorders.

The National Institute for Occupational Safety and Health (NIOSH) (1984) conducted questionnaire surveys in respect of VDT workstations and evaluated them for ergonomic problems. The results indicated that VDT operators reported frequent visual and musculoskeletal strain and discomfort. The visual complaints were most frequently related to eye fatigue and blurred vision. The musculoskeletal complaints were of pain or stiffness in the neck, shoulders, back, arms wrists and hands. These effects were most noticeable among operators who were engaged in repetitive VDT work with little work variation, spent excessive periods of time working without rest periods undertook VDT tasks of high visual intensity. Operator complaints were most often related to glare, poor lighting and ergonomically deficient workstations.

Grandjean (1987) found that prolonged use of video display terminals was a risk factor for musculoskeletal and visual discomfort. Bridger (1995) stated that the predominant problems associated with VDT work are fixed postures and cumulative trauma disorders. Marriot and Stuchly (1986) stated that improvement in the ergonomic design of workstations could reduce musculoskeletal and visual discomfort of the operators.

Liad and Drury (20000) in their study of VDT operators found that an increase in the musculoskeletal discomfort of operators let to an increase in the rate of postural changes and this in turn had a detrimental effect on the performance of the worker.

Due to the increase in the number of musculoskeletal disorders among VDT users, the term cumulative trauma disorders or repetitive strain injury was coined to describe, "pain and discomfort in the hands, arms, shoulders and neck of workers involved in repetitive, non-varied work and who were forced by their work and the workplace to maintain awkward, fixed postures for long periods during the working day".

In 1987 the Council of Scientific Affairs estimated that by the year 2000, 100 million VDTs would be in use in the United States of America alone. Due to the vast number of VDTs in use, even a small health risk associated with their use would have important health implications.

The precise cost of occupational musculoskeletal disorders (MSDs) is not known. An estimate published by NIOSH in 1996 gave a conservative estimate for the United States of America of $13 billion per annum. The problem is large, both in health and economic terms. Work related MSDs are a major component of the cost of work-related illnesses. The lack of effective medical treatment of injuries together with the evidence that there are behavioural risk factors (e.g. working for excess time periods without breaks, incorrect positioning of components of a VDT workstation) has led to the use of employee training programs. There has been a large investment by employers in training employees but little has been invested in ascertaining the effectiveness of these programs.

It is hypothesized that employee education would lead to early detection of cumulative trauma disorders (CTDs), preventing the condition from becoming disabling and promoting rapid and full recovery. All employees should be educated at to the causes and early symptoms of CTDs and be encouraged to report symptoms to their supervisors. All levels of management should be given ergonomic training to enable them to manage their staff appropriately.

Ergonomic design problems surrounding VDTs are many and diverse. They are concerned with the technology of the visual display, the workstation layout, the type of task and the environment within which they operate.

Ergonomic research (refer to paragraph 4.8) has lead to various recommendations for keyboard height, break schedules, work postures, workstation design and work organization. These recommendations may result in improved comfort, reduced muscle tension, reduced visual fatigue and greater productivity. These studies can be used to identify risk factors which can be evaluated whilst observing VDT operators in the workplace.

Demure et al. (2000) found that the provision of adjustable workstations did not ensure that VDT operators, untrained in the field of ergonomics, would adjust the equipment correctly. They found that VDT operators accomplished the work in the "easiest way" and not the "healthiest way". It is therefore of no value to just supply operators with adjustable furniture, they need to be trained in the correct use and layout of this equipment in order to effect positive ergonomic change in terms of their own anthropometrical differences.

3 OBJECTIVES

The objective of this study was to evaluate the effectiveness of an ergonomic training program by using a prospective, cohort study of randomly selected VDT users (that is those VDT workers who operate a VDT a minimum of four hours per day).

The training program would be evaluated by:

3.1 Monitoring the ergonomic changes implemented in the workplace, which would reduce the risk of visual fatigue and musculoskeletal disorders by using an Ergonomic Checklist (Appendix 5) before and after intervention.

3.2 Monitoring the reduction of health complaints as a direct consequence of ergonomic changes implemented by employees using a "Symptom Survey" questionnaire before and after intervention, (Appendix 3 &4).

The first goal of the training program was to sensitize the employees to the ergonomic requirements of their workstations. Training them to be able to identify critical ergonomic aspects of their work and health complaints associated with the use of VDTs. The second goal was to give them the knowledge to make the necessary changes to their workstations so as to optimize their own conditions of work and to provide them with alternatives for controlling the identified problems.

The training was accomplished by means of a lecture (one-hour) about ergonomics at the workplace of VDT operators. The lectures were supplemented by a video (Office Ergonomics, Coastal Training, Learning resource) giving a practical demonstration of how the VDT workstation could be made more ergonomically correct and also by the distribution of a leaflet setting out the criteria for an ergonomically correct VDT workstation.

The workstations of 48 randomly chosen VDT operators were assessed by means of an Ergonomic Checklist (Appendix 5) and the nature, prevalence and quality of the workstations documented.

4 LITERATURE REVIEW

4.1 OCCUPATIONAL MUSCULOSKELETAL DISORDERS

4.1.1 Pathogenesis of injury

Musculoskeletal disorders include a group of conditions that involve the nerves, tendons, muscles and supporting structures such as the intervertebral discs. Some musculoskeletal disorders have specific diagnostic criteria and clear pathological mechanisms for example hand/arm vibration syndrome. Others are defined primarily by the location of pain and have a more variable or less clearly defined pathophysiology, for example, back disorders.

4.1.2 The body's response to static loading

Static loading occurs when the head or limbs are maintained against gravity, when the postures do not return to normal, or if there is continuous loading of one muscle group. The author is not suggesting that all muscle activity is potentially harmful. Muscles and tendons are strengthened by repeated activity if there is sufficient time for recovery and the postures are not potentially harmful.

4.1.3 Muscle pain

Veiersted et al. (1990) stated that repetitive muscular activity could lead to the development of muscular pain.

Local muscle fatigue and discomfort may be a forerunner of repetition strain injuries. Long term low level contractions of the muscles results in local hypoxia (lack of oxygen) due to increased intramuscular pressure. Muscle pain could be caused by the accumulation of waste products, which can lead to muscle weakness and spasms.

Myalgia (muscle pain) may result when the repair capabilities of the muscle are outstripped by the cumulative damage. Ranney et al. (1995) concluded that muscle tissue was highly vulnerable to overuse and that friction as well as force of contraction is important in the development of tendon pathology.

4.1.4 Tendon pain

Goldstein et al. (1981) stated that deformation and fraying of the tendon could be caused by mechanical wear, shearing of the synovium and reduction in nutrition. With constant loading the tendon will continue to elongate resulting in cumulative strain. Increased tension reduces the blood supply in the tendon causing increased cell death and degenerative changes.

Frequent loading of a tendon causes tendonitis (inflammation of tendon) which is caused by friction against the tendon sheath and bony prominences. Tenosynovitis (inflammation of the tendon sheath) is caused by rapidly repetitive movements and results in the production of excess synovial fluid and possibly scar tissue which reduces function due to reduced movement of the tendon in its sheath.

4.1.5 Nerve pain

Nerve tissue can be damaged as a result of impingement, mechanical stresses or the reduction in circulation. Excess muscle pressure on nerves can result in conduction impairment, this manifests as numbness or tingling.

4.1.6 Bones and joints

Joints can be damaged by exposure to high forces and extreme postures, which in the long term, are risk factors for the development of osteoarthritis. Osteoarthritis is a non-inflammatory disease of the joint causing degeneration of the articular cartilage, hypertrophy of the bone and changes to the synovial membrane resulting in pain and stiffness of the joint.

4.2 VISUAL FATIGUE IN VDT OPERATORS

Bergqvist et al. (1994) concluded, in a study of 327 office workers using VDTs, that the use of a VDT is associated with an increased incidence of eye discomfort.

Grandjean (1983) stated that Ostberg in his study of, "Accommodation and visual fatigue in display work", found that there were temporary accommodation after-effects caused by VDT work showing that visual fatigue may result from VDT work. The directive stated that there should not be excessive differences of luminance in the operators' field of vision, that the screen should be fully adjustable for inclination and visual distance, that the ambient light should be adjusted according the type of task being done, that well shielded supplementary lighting should be provided for other work areas and that operators should be given intermittent rest breaks before visual fatigue developed.

Gunnarsson et al. (1983) found that rigid work routines of long duration were associated with increased frequency of visual strain in VDT work.

Watten et al. (1992) concluded that prolonged VDT work lead to a decrease in visual acuity which was as a result of a decrease in the eyes ability to sense contrast.

Collins et al. (1990), in their research into the relationship between workstation factors and visual symptoms, found that the legibility of screen text and the number of vertical head turns had a significant effect on the reported frequency of ocular discomfort.

4.3 VISUAL DEMANDS OF VDT WORK

VDTs were introduced into the workplace where the lighting and workstation arrangement were designed for manual writing or typewriting. This mismatch between visual task and visual environment contributes to the ocular discomfort felt by many VDT operators.

VDT work is primarily a visual task. It not only refers to reading from the screen but also extends to the reading of hard copy, and therefore knowledge of "visual ergonomics" is important to the success of any VDT ergonomics program. "Visual ergonomics" adapts the workplace to the visual abilities of the operator. Visual discomfort occurs at a VDT when the visual demand of the task surpasses the visual capacity of the operator. VDT work can be visually demanding due to the image on the screen, the workstation design or the type of tasks performed.

4.3.1 Vision and the eye

The visual system has been likened to an "information gatherer"; light enters the eye carrying information to the brain. The better the quality of the information gathered by the eye, the greater our ability to perceive and interpret it. Our eyes must adapt to a range of viewing distances and illumination levels to allow us to operate efficiently.

4.3.2 Accommodation of the eye

Accommodation is the process by which the eye adapts to maintain clear focus as the object being viewed is brought closer to the eye. This is achieved by the refractive power of the lens, which focuses the image onto the retina. The resting point of accommodation, (approximately 80cm in young people and further in older people), is the distance at which the eyes focus where there is no object to focus upon, at which point the accommodation is said to be "relaxed". Viewing of a VDT closer than the resting point of accommodation can lead to eyestrain due to the increase of the workload on the ciliary muscles of the lens. Moving the screen further away will reduce the amount of accommodation necessary to view the screen. The only limiting factor to the viewing distance of the screen is the size of the characters and the workstation layout. Characters on a cathode ray tube always have blurred edges, which results in "accommodation strain". Tasks that require the eyes to repeatedly change the point of focus increase the accommodation stress on the eye (e.g. from screen to hard copy).

Lie and Watten (1992) found that overuse of the accommodation and vergence systems of the eye resulted in increased tension in the muscles of the neck and upper body.

4.3.3 Convergence of the eye

Viewing objects at close range causes the eyes to converge (turn inward toward the nose). The closer the object, the greater the strain on the muscles of convergence. Therefore long hours of close visual work cause imbalances in the muscles and lead to an increase in visual fatigue. The further the distance from the screen, the less the eyes have to converge which results in less ocular fatigue. Due to the fact that the resting point of convergence moves inward when the line of vision is directed slightly downward, therefore lowering the screen will reduce the demand for convergence of the eyes.

4.3.4 Retinal adaptation

The eye controls the amount of light falling on the retina by changing the diameter of the pupil. A large variation between the screen and the surrounding area (visual field) causes the pupil to continually adjust and results in the eyes being "dazzled" by "retinal after-images". When the eyes change their focus from a dark object to a lighter one there is a "veiling effect" on the eyes caused by the delay in retinal adaptation to the dark. Due to fact that the gaze is involuntarily drawn to bright objects in the visual field, the task (screen) should be the brightest area in the visual field. If the ambient light is brighter than the screen, the eyes will light adjust to the ambient light and the screen will appear dim, e.g. when the back of the screen faces a window.

4.3.5 Glare and VDTs

Glare occurs when there is an imbalance of luminances in the visual field and can be caused for example by the sun, unshielded light and highly reflective surfaces reflecting the light.

The reflective nature of the VDT screen increases glare, which can cause eye discomfort or impaired legibility of screen text. Glare from windows and overhead lighting is more of a factor in VDT operation because the line of sight is more horizontal than for manually written work.

4.3.6 Visual fatigue and the "Dry eye" syndrome

Tsubota and Nakamori (1993) stated that ocular fatigue was a common complaint amongst VDT operators and that he main cause of ocular fatigue is dry eyes it was therefore hypothesized by the researchers that VDT work exacerbates drying of the surface of the eye. The researchers therefore recommended that operators lower the height of their screens and tilt it slightly upwards, resulting in the line of sight being slightly below the horizontal, thereby reducing the eye surface exposure and the consequent evaporation of moisture from the eyes.

Bridger (1985) in his book, Introduction to Ergonomics, pg. 255, suggested that the "dry eye" syndrome could be caused by the reduced blinking rate of VDT users and also by the increased tear evaporation caused by increased eyeball exposure due to horizontal viewing of the screen. Air-conditioned buildings with poor control of the ambient humidity further exacerbate this "dry eye" syndrome. He also stated that encouraging VDT operators to blink more often could reduce the "dry eye" syndrome.

Jaschinski et al. (1996) stated that visual fatigue, resulting from decreased visual function, experienced by VDT operators could be as a result of the intermittent light emitted by VDT screens.

4.4 PREVALENCE OF MUSCULOSKELETAL DISORDERS IN VDT OPERATORS

Demure et al. (2000) in their study of 273 VDT operators found that there was association between the sites of musculoskeletal discomfort and the ergonomic characteristics of the VDT workstations. They also found additional evidence that musculoskeletal discomfort in VDT operators is dependent on a variety of factors for example the ergonomic characteristics of the workstations, the number of hours of daily exposure and psychosocial stress.

Liad and Drury (2000) in their study of VDT operator tasks found that there was a correlation of various multiple factors such as the ergonomics of the workplace, duration of work, musculoskeletal discomfort, working posture and performance.

According to Bridger (1985), fixed postures and cumulative trauma disorders (CTDs) are the main musculoskeletal problems analogous with VDT work. The “fixed postures” of the head, neck and trunk are dictated by the arrangement of the workstation and equipment. According to Grieco (1986) static postures adopted by VDT workers results in isometric muscle contractions which leads to a depleted blood supply and muscle fatigue. The CTDs are associated with the repetitive task of data entry.

Munshi et al. (1984) in their study of workstation design confirmed that failure to apply ergonomic principles to VDT workstation design resulted in operator discomfort and fatigue. The position of the keyboard, screen and hard copy in the workspace determined the operator posture and efficiency. The lack of document holders was cited as the main factor causing visual and postural problems.

The following is a summary of some of the consequences of ergonomic deficiencies arising out of the use of VDTs as postulated by the following researchers:

Kroemer (1972), described the postures usually assumed by keyboard operators as "unnatural, uncomfortable and fatiguing".

Marcus et al. (1996), concluded that a history of VDT use was associated with an increase in the prevalence of musculoskeletal disorders of the neck, shoulder, hand and wrist. NIOSH (1990), in their cross sectional study on 834 subjects using VDTs, found that a higher rate of typing is commensurate with a higher incidence of musculoskeletal disorders of the hand/wrist, elbow/forearm and neck.

Bergqvist et al. (1992), in a prospective study of VDT users, concluded that those who used VDTs were 2.5-4 times more likely to developed hand/wrist or back symptoms than those who did not use VDTs. Bergqvist (1984), also found that increased musculoskeletal discomfort during VDT work was consistent with reports of increasing pain as a function of work hours.

Hultgren et al. (1974), reported musculoskeletal discomfort, symptoms of "pain, stiffness, fatigue, cramps, numbness and tremor", among office workers using VDTs.

Armstrong et al. (1993) postulated that there was a progression of musculoskeletal symptoms, which started with musculoskeletal discomfort at work that disappeared at rest. If the exposure to the risk factor for musculoskeletal injury continued, the pain may persist after work and eventually become a chronic disorder with pain occurring at work and at rest. Chronic disorders may develop, if no remedial action is taken. These disorders may become irreversible even with treatment and termination of work. The employee may be forced to seek other employment options or to continue doing the job but with reduced efficiency.

4.4.1 Musculoskeletal disorders of the neck and shoulder

Literature emphasizes the importance of correct positioning of the VDT screen, in order to prevent musculoskeletal disorders of neck and shoulder.

Grandjean (1987), in his publication, "Ergonomics in computerized offices", concluded that if the head and neck were flexed forward more than 15 degrees this would lead to undue stress on muscles of the neck. Kumar (1994) found that muscle activity in the neck and back increased as neck extension increased with corresponding feelings of discomfort in the neck. In order to prevent excessive flexion or extension of the neck, which results in increased static muscle tension, the top of the screen should positioned in line with or slightly below the eye line of the operator.

Sauter et al. (1991) in a study of several hundred VDT users found that there was clear evidence that ergonomic factors affected musculoskeletal discomfort. It was also concluded that arm discomfort increased with increases in keyboard height above elbow level, which supported the argument for low placement of keyboards.

Wiker et al. (1989) in his research into the causes of shoulder fatigue recommended that jobs should be designed so that the hands are held at waist level, as close to the body as possible and that the shoulder movements should be minimized. He also stated that it was anticipated that "comfortable working postures" would "reduce the risk of musculoskeletal disease".

Nisell et al. (1992) found that neck and shoulder disorders could be attributed to repetitive tasks with high requirements of accuracy and precision.

The following researchers found that work technique was also an important variable and concluded that the teaching of work postures and techniques should be given a high priority.

Pascarelli and Kella (1993) in their study of injured VDT operators found that improvement of the work technique played an important roll in the prevention of injury. Learners and those operators who used one finger to type were at a higher predisposition for injury to the wrists, fingers and shoulders.

Fernstrom (1996), in corroboration found that persistent shoulder and neck disorders in "ergonomically designed workstations" were attributable to poor work organization, excessive time spend at the VDT and poor knowledge of work technique.

Melin (1987) found that employees suffering from neck-shoulder disorders had significantly higher loading of the shoulders and neck resulting from moving their arms forward and outwards. She also stated that good working technique (ability to carry out complex movements with minimum effort) resulting from early training saves energy and reduces fatigue.

Kilbom (1987), in corroboration found that work techniques of some individuals placed excessive strain on the neck and shoulders. As the percentage of work cycle time with forward flexion of the neck increases so does the risk of neck and shoulder increase. The conclusion is therefore drawn that those operators who are unable to touch type (type without looking at the keyboard) are at a greater risk of neck and shoulder injury.

4.4.2 Musculoskeletal injuries of the wrists

Malpositioning of the wrists, whilst using the hands, can lead to various types of injuries because the wrist is a duct through which many structures pass e.g. forearm flexor and extensor tendons, which activate the fingers. The tilted keyboard facilitates the placing of the forearms on the table with resultant ulnar deviation and dorsiflexion. This distorted wrist posture combined with repeated forearm muscle use results in friction of the flexor tendons ultimately leading to muscle damage and tendonitis.

Matias et al. (1998) in their study of one hundred (100) female VDT operators found that the risk of carpal tunnel syndrome, the most common cause of disabling injuries in VDT operators, increased as a result of increased exposure (percentage of time spent working with a VDT) and increased wrist extensions and ulnar deviations. The researchers were of the opinion that ergonomic interventions in the design of VDT workstations would reduce the incidence of CTS.

Stock (1991) in her review of fifty-four (54) studies regarding workplace musculoskeletal disorders of the neck and upper limbs found strong evidence of a causal relationship between repetitive, forceful work and the development of musculoskeletal disorders of the tendons in the hands and the wrists.

According to Bridger (1985) the incidence of injury is greater in VDT operators than in traditional typists, which could be due to the inherent breaks that are built into a typists tasks e.g. manual operation of carriage, changing paper, correction of errors. In word processing these tasks are automated and the keyboard tasks are less varied. Another reason for the higher incidence of injury could be due to the lack of formal training in keyboard skills received by most VDT operators as opposed to traditional typists who all received formal training.

4.5 TRAINING

The National Institute for Occupational Safety and Health (NIOSH) (1995) states that the successful implementation of an ergonomics program depends on the involvement of all members of the organization. This applies to all employees at risk as well as other employees whose job responsibilities may influence the ergonomic risks of others e.g. managers, supervisors, engineers and buyers.

A training model should consist of the following steps (OSHA 1992):

4.5.1 Determining the need for training:

(a) As determined by the work site analysis and medical surveillance.

(b) Job/risk-specific training for employees and their managers.

4.5.2 Identifying training needs:

The course contents should include the following information:

(a) Types of work-related musculoskeletal disorders and the risk factors associated with them

(b) Prevention and control strategies for reducing ergonomic hazards

(c) The organizations procedure for reporting ergonomic risks

(d) Information regarding the structure of the ergonomic management program

(e) Job/risk specific training should be provided for those employees who are exposed to specific ergonomic hazards

4.5.3 Identifying goals and objectives

(a) Well-defined, measurable goals should be set, which are specific to the type of job and risk exposure.

(b) Objectives will be identified according to the medical surveillance and work site analysis

4.5.4 Conducting the training

(a) Training should be compatible with the level of education and background of the individual

(b) Annual refresher courses should be held to maintain motivation and allow for employee feedback

4.5.5 Evaluation of training

Evaluating the program effectiveness, with surveys and demonstrations of behaviour change.

4.5.6 Improvements of program

Improving the program by using the information gathered in the evaluations performed and revising the training program accordingly.

4.6 EFFECTIVENESS OF TRAINING

Kilbom et al. (1987) found that poor work technique was a high risk factor for disorders of the neck and that training should be administered to new employees to improve work techniques. Kilbom (1988) also suggested that the main function of the researcher should be to teach hazard awareness and monitor the effects of intervention. He stated that researchers should be able to convince management of the cost effectiveness of their intervention before expecting companies to invest in ergonomic changes.

Pascarelli et al. (1993), during his study of 53 disabled keyboard operators, found that changes in the workstation alone was not sufficient treatment. A multifaceted approach was recommended which included physical therapy, technique training, education and counseling.

Cole (1984) stated that the evaluation of an ergonomic training program should occur at two levels. The first evaluation should be done immediately after the training to assess the comprehension and clarity of the course and the second evaluation should be done at the workstation in order to establish actual practice.

4.6.1 Negative results

The following researchers found no improvement or a negative relationship between ergonomic training and improvements in the work methods:

Coury (1998) evaluated an auto-instructional preventative program delivered to thirty-six (36) secretaries and bank clerks enabling them to identify and correct ergonomic problems in their workplace. The results showed that the musculoskeletal symptoms increased and the author concluded that a self-administered program when applied in isolation created negative results possibly due to increased awareness by the participants.

Snook et al. (1978) in his study of preventative approaches to low back injury concluded that training on safe lifting procedures is not an effective control for low back injuries. The results showed that only the ergonomic redesign of the lifting tasks to reduce the workers exposure to manual handling reduced low back injuries.

St. Vincent et al. (1989) in the assessment of the effectiveness of a "handling program" showed that the handling principles that had been taught were not often used in the workplace. The results indicated that the training program was not well adapted to the handling of patients (it could not always be applied) and that some of the methods of handling taught were disputable. Stubbs et al. (1983) corroborated this finding in his study of nurses. He found no association between receiving ergonomic training and a decrease in the prevalence of back pain.

4.6.2 Positive results

The following researchers found a positive association between training and improved work methods:

Brisson et al. (1999), in their study on the effects of ergonomic training used an experimental (received training) and control (did not receive training) group of VDT operators found that there was a greater reduction in musculoskeletal discomforts in the experimental group. This was particularly evident in the VDT operators under the age of forty years.

Menozzi et al. (1999) carried out self-help, ergonomic training program for VDT operators in a large Swiss company. According to the results it was found that the training improved the ergonomic conditions of the company and was also cost-effective.

Backburn et al. (1992), viewed the absence of ergonomic training as a risk factor affecting the well-being of the worker and the function of the organization. Liker (1990) found that training when used as part of an ergonomics program increased worker awareness of ergonomic risks.

Dortch et al. (1990) evaluated the effect on hand-use patterns of industrial workers using two types of educational programs. The results of the study showed that both the "handout" (use of pamphlets and other instructional literature) method and the "hands-on" (demonstration and correction of work techniques in the work place) methods could effect hand-use patterns. McKenzie et al. (1985) corroborated this finding using a sample of 6 600 workers, who operated hand tools in the telecommunications industry. He found that ergonomic training as part of an ergonomic program resulted in a reduction of repetitive motions.

Feldstein et al. (1993) developed a pilot study of "Back Attack", an educational program designed to prevent back injuries among nurses, nurse aides and orderlies. The results of the study showed that the program changed behaviour in the short term.

Orgel et al. (1992) concluded that grocery checkout workers benefited from ergonomic training, as part of an ergonomic program, in that it resulted in reduced absenteeism and reduced medication requirements.

Luopajarvi (1987) carried out a program, to evaluate the effectiveness of ergonomic training, the aim of which was to study whether musculoskeletal disorders of the neck and shoulder could be prevented by health education and improvements in the workplace. The effects were assessed through a medical examination of the neck and arms at the beginning and end of a six-month period. The results of the study showed a decrease from 54% to 16% of "tension neck syndrome" and it was concluded, "health education was linked with simultaneous actions in the workplace".

Rowe (1987) developed a control system for the prevention of musculoskeletal symptoms in VDT users. The program included education of managers and operators, workstation assessment and improvement and workload analysis. This study concluded that a positive approach to prevention and rehabilitation is of value in reducing the incidence of musculoskeletal disorders.

Engels et al. (1997), in their ergonomic assessment of errors made by nurses found that they made fewer errors immediately after an ergonomic training course and even fewer errors a year later. Hellsing et al. (1993) corroborated this finding while observing the work methods of nurses. Those nurses, who had received ergonomic training, worked using better body postures. This resulted in a decreased amount of physical strain on the body.

4.6.3 Commentary

The development and delivery of training programs aimed at prevention and intervention, is the first step in implementing effective prevention programs. Equated with this is the need to evaluate and confirm the effectiveness of these training programs.

The review of eighteen (18) research papers relating to the effectiveness of training in altering behaviour showed fourteen (14) positive, four (4) negative and two inconclusive results. The effectiveness of training is often difficult to evaluate and therefore the success of the training program is difficult to establish.

The negative results found by Coury (1998) could be attributed to an increased awareness of MSDs and their possible work relatedness together with fact that they were now given a platform to express their discomfort. The negative results found when training employees in safe lifting techniques, Snook (1978), could be as a result of the fact that if a lifting task is inherently unsafe no amount of training would reduce the hazards of the lifting task. St. Vincent's (1989) lack of success in teaching handling techniques to nurses could be attributed to the fact that these techniques could not be applied in a hospital situation and it was therefore not a suitable program for the training of nurses.

The majority of the papers reviewed showed a positive association between training and improvements in work methods. It was found that worker awareness increased which resulted in the increased well being of the worker. Reduction of absenteeism, reduction in the use of medication and reduction of complaints of MSDs were also noted. Luopajarvi (1987) found that health education was positively linked to behaviour in the work place. Both Dortch (1990) and Mckenzie (1985) showed that industrial workers could change their "hand-use patterns". The work methods of nurses, as assessed by Engel (1997) and Hellsing (1993), found reduced physical strain after completion of ergonomic training in that they used better body postures.

The evidence shows that training programs when sufficient in scope and appropriate to the task do lead to improvement in work methods and a reduction in MSDs.

4.7 VIDEO DISPLAY TERMINAL WORKSTATIONS: RISK FACTORS Adapted from Introduction to Ergonomics, Bridger, (1995)

Risk factors are elements of a job that increase the chance of work-related injury. The potential for injury is affected by the duration of exposure.

Prolonged sitting has been identified as the main contributory factor to back pain in sedentary workers but other ergonomic factors also need consideration in the design of an ergonomically correct the workstation. For example poor posture and poor seating arising out of incorrect adjustment or chair design lacking in ergonomic input.

Computer "height", seat "height", desk "height" and position of the monitor in relation to the worker have a significant impact on posture and body alignment. Operators may have to maintain a flexed or rotated posture in order to reach the work surface or view the monitor. If these activities are frequently repeated they constitute risk factors for musculoskeletal injuries.

4.7.1 Risk factors for the development of cumulative trauma disorders

(a) Static or awkward posture

(b) Forceful hand exertions

(c) Repetition of the same motions

(d) Insufficient number of rest breaks

4.7.2 Prevention of cumulative trauma by eliminating or reducing risk factors:

By the establishment of ergonomically correct workstations, which allow for postural change, adoption of neutral postures and where work organization allows for rest breaks.

4.7.3 The VDT workstation should support the operator as follows (Fig 1):

(a) feet flat on the floor (or footrest)

(b) thighs parallel to the floor

(c) back resting against the lumbar support

(d) head and neck upright

(e) elbows comfortably against the sides of the body

(f) wrist and forearms parallel to the floor

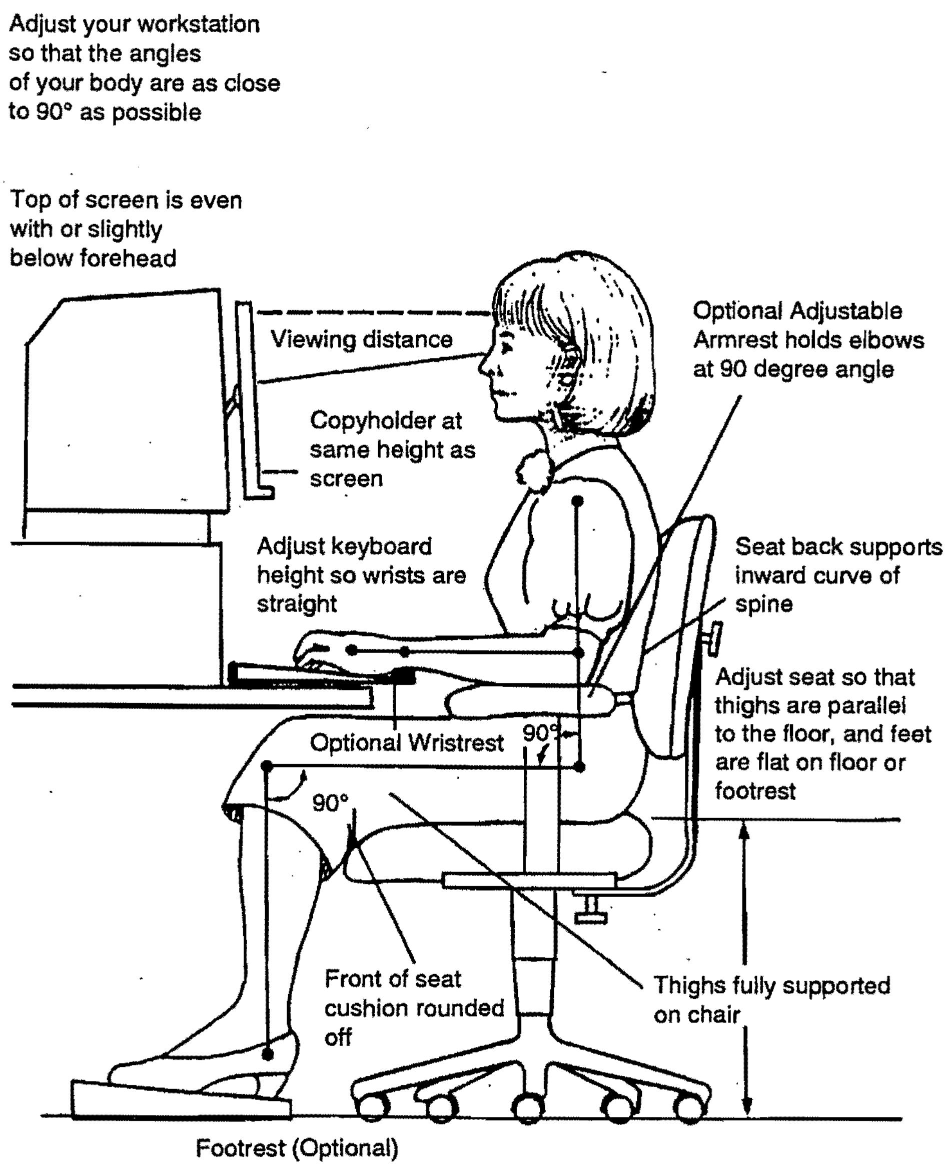


Fig 1 Criteria for ergonomic arrangement of VDT workstation (Drawing courtesy of Warner-Lambert, Ergonomics for video display terminal operators).

4.7.4 Elements of an ergonomically correct workstation (Fig 1)

(a) The workstations should consist of an adjustable chair, which supports the operator and is of the correct anthropometrical fit.

(b) The work surface should be of the correct height and size for the tasks to be performed.

(c) A computer monitor and keyboard positioned at the correct height relative to the body of the operator.

(d) The mouse should ergonomically designed and placed next to and at the same height as the keyboard.

4.8 MINIMUM REQUIREMENTS OF A VIDEO DISPLAY TERMINAL WORKSTATION

The standard upon which this thesis is based is derived from the "Work with Display Screen Equipment, Proposals for Regulations and Guidance issued by the Health and Safety Commission under Sections 50(3) of the Health and Safety at Work Act 1974", United Kingdom together with the Warner-Lambert Corporate Standards, Bridger (1985) and Cakir et al. (1980).

4.8.1 Display screen

Display stability: a screen that is found to be "flicker-free" by 90% of users is a minimum requirement in order to reduce the risk of eye fatigue.

Brightness and contrast

The screen should contain controls for the adjustment of brightness and contrast so that it can be adjusted according to the level of ambient lighting and the screen should be brighter than the surrounding light sources.

Screen adjustability (Fig 1)

The screen should be fully adjustable for height, with the top of screen positioned at eye level (or slightly below eye level), reducing postural load on the muscles of the neck (Fig 2 & 3).

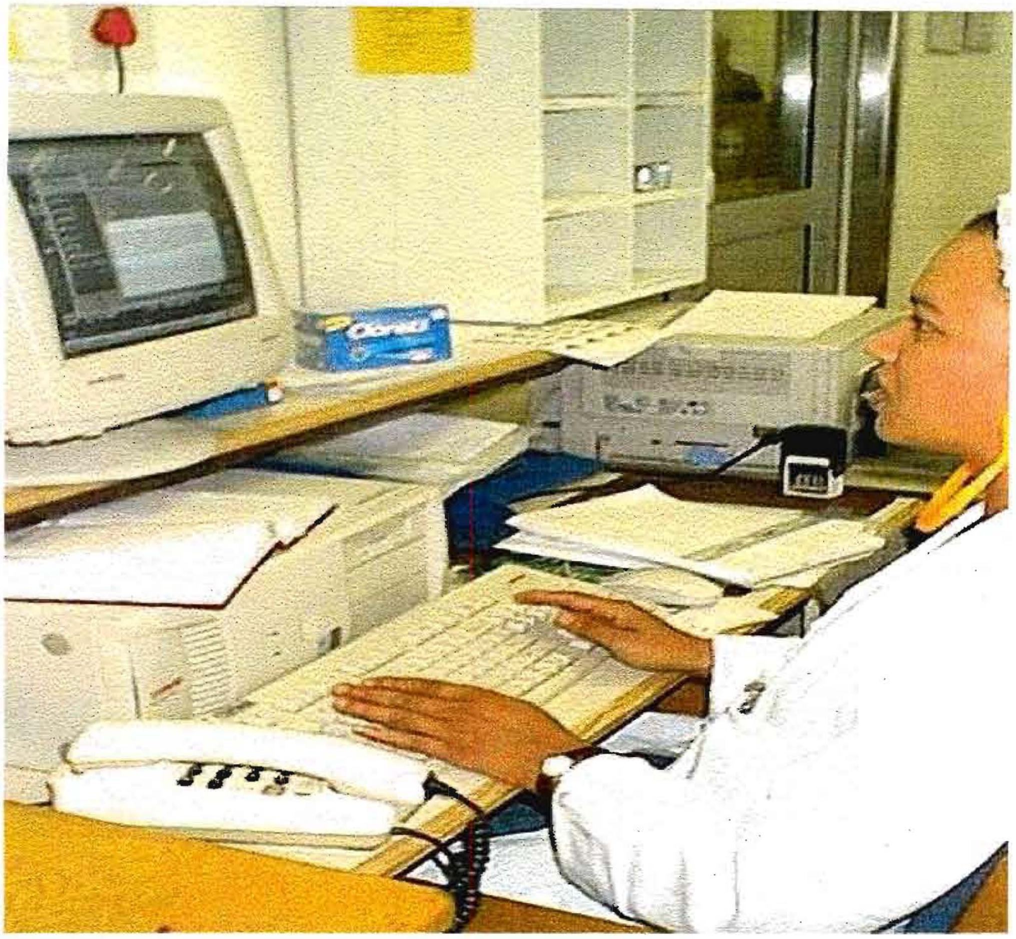


Fig 2 Incorrectly positioned screen, with eye line lower than the top of the screen and insufficient desk top space

Reduction in glare can be achieved by placing the screen at right angles to the light sources, using indirect lighting, shading, shielding or repositioning light sources, reducing the reflectability of the surrounding surfaces, placing overhead lights out of the user's field of vision and by using a screen filter.

4.8.2 Keyboard (Fig 1)

The keyboard should be positioned directly in front of the operator to reduce twisting of the trunk and approximately 6cm from the edge of the work surface to allow for space to rest the forearms during rest breaks in typing.

Keyboards can be flat or angled slightly upwards at the back, (by raising the legs under the keyboard the back of the keyboard can be raised approximately 2cm), to enable the operator to easily reach the keys whilst keeping the wrists in a neutral position.

4.8.3 Work surface

Work surface dimensions should take into account the tasks to be performed so as to allow sufficient space for documents and other equipment, (e.g. screen and keyboard), to be placed in the correct position in respect of the operator.

4.8.4 Document holder (Fig 6)

If the hardcopy is placed on the desk to the side of the keyboard, operators must twist and flex their necks in order to look from the screen to the document and visa versa. This causes repetitive neck flexion resulting in increased muscle activity in the cervical muscles and static loading of the muscles which is a risk factor for musculoskeletal disorders of the neck as well as eyestrain due to an increased need to refocus the eyes.

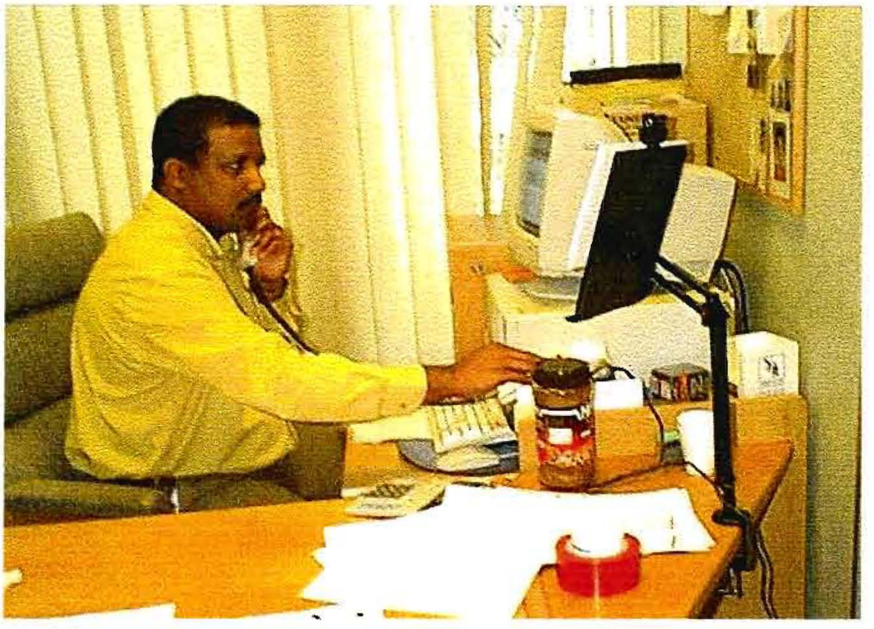


Fig 6 VDT workstation with document holder at same height as screen

4.8.5 Chair (Fig 1)

The efficiency of a posture is determined by the degree to which it loads the skeleton and the postural muscles of the body. The effects of sitting in an incorrect position are manifested in musculoskeletal disorders of the spine and fatigue of the back muscles. When working at a VDT the operator is supported in three positions, with the lower back on the lumbar support, the feet on the ground and the buttocks and the thighs on the seat pan. The seat of the chair should be designed so as to support the sitter in a comfortable position, maintaining a stable posture with the feet on the floor. If the operators feel unstable they will adopt postures such as crossing their legs in order to lock the joints and stabilize the body (Fig 7).

A chair design should incorporate the following features, seats should swivel on a five point base for stability and be height adjustable between 38 and 54cm.

The **seat pan** of the chair should be pneumatically height adjustable to accommodate the anthropometry of the user. The depth of the seat pan must be able to accommodate the shortest operator and the width the widest operator, (if the seat pan is too deep the operator will not be able to use the lumbar support) (Fig 7). The seat pan must be slightly hollowed in the buttock area to prevent the user's pelvis from sliding forward and the leading edge should curl downwards to reduce pressure on the back of the knees and thighs. The seat pan should be made of a high-density padding and covered with cloth upholstery to increase friction and stabilize the operator.

The **lumbar support** must support the lower back from 12,5cm to at least 20cm above the seat pan with free space above the seat pan to allow for the posteriorly protruding sacrum and buttocks. This reduces static muscular work necessary to stabilize the trunk of the body in a sitting position, helps to maintain the correct lumbar curvature and prevents rotation of the pelvis. The height and tilt of the lumbar support should be adjustable so as to allow for change of posture as prolonged sitting in a fixed position can lead to discomfort due to lack of blood circulation in the muscles

4.8.6 Footrest (Fig 1)

Footrests improve postural stability and are required for those workers whose feet do not comfortably rest on the floor when their chairs are correctly adjusted for height (Fig 7). Using a fixed desk height and a variable seat height the correct leg posture for a smaller person can only be achieved with the aid of a footrest. The thighs should be horizontal with the feet so as to give a 90-degree or slightly greater bend angle at the knee. A variable footrest, which accommodates variations in height and minor postural changes of the lower limbs, assists circulation and reduces under thigh pressure.

4.8.7 Space requirements

There must be sufficient space for thighs, knees, lower legs and feet under the work surface to allow for postural change and to allow the operator to comfortably reach the keyboard.

4.8.8 Lighting

According to Cakir et al. (1980), VDT working areas should be illuminated with 300 to 500 Lux illuminance. However, as the level of light falls below 500 Lux, supplementary lighting of documents at the VDT workstation may be necessary. All light sources should be shielded in order to reduce both direct and indirect glare.

Fig 8 Eye level below the top of both display screens, elbow rests do not fit under desk and incorrect positioning of both mice.

4.9.2 Keyboard design

Keyboard design has received a lot of attention due to the prevalence of repetitive strain injuries (e.g. tendonitis, carpal tunnel) pertaining to the wrists of VDT operators.

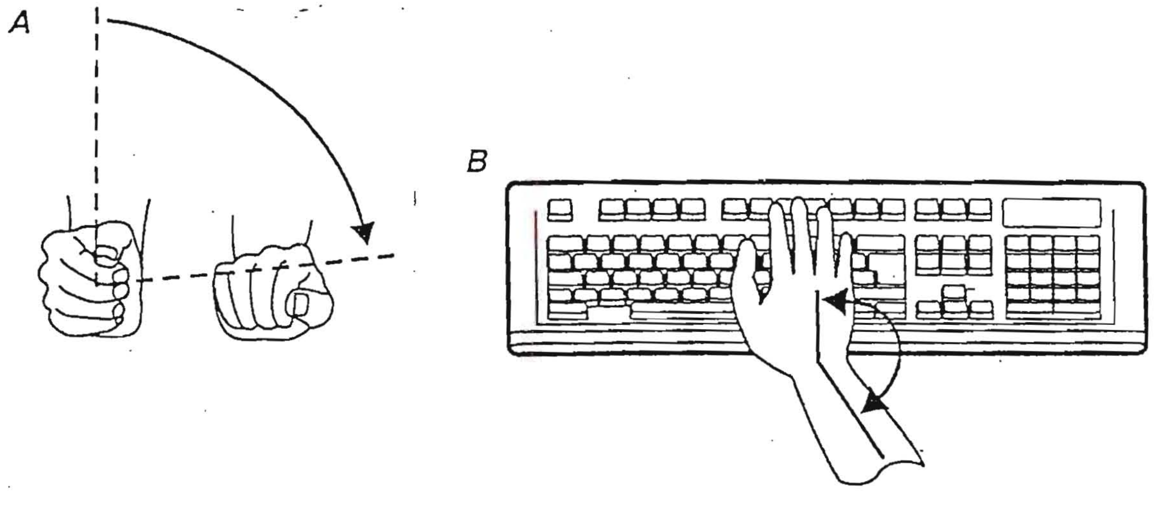
VDT operators often use awkward non-neutral work postures when working on VDT keyboards. They adopt a posture of ulna deviation and wrist flexion as well as rotating their arms so that their palms are facing the keyboard (Fig 9). Operators also tend to abduct their elbows particularly if the work surface is too high or the armrests are too far apart (Fig 10).

Baidya et al. (1988) found that the extensor muscle of the arm tired faster if the wrist was held in the extension position

Fig 9 A. Operators rotate their arms so that their palms are facing the keyboard

B. Operators adopt a posture of ulna deviation and wrist flexion

(Drawing courtesy of National Institute for Occupational Safety and Health, Alternative Keyboards)



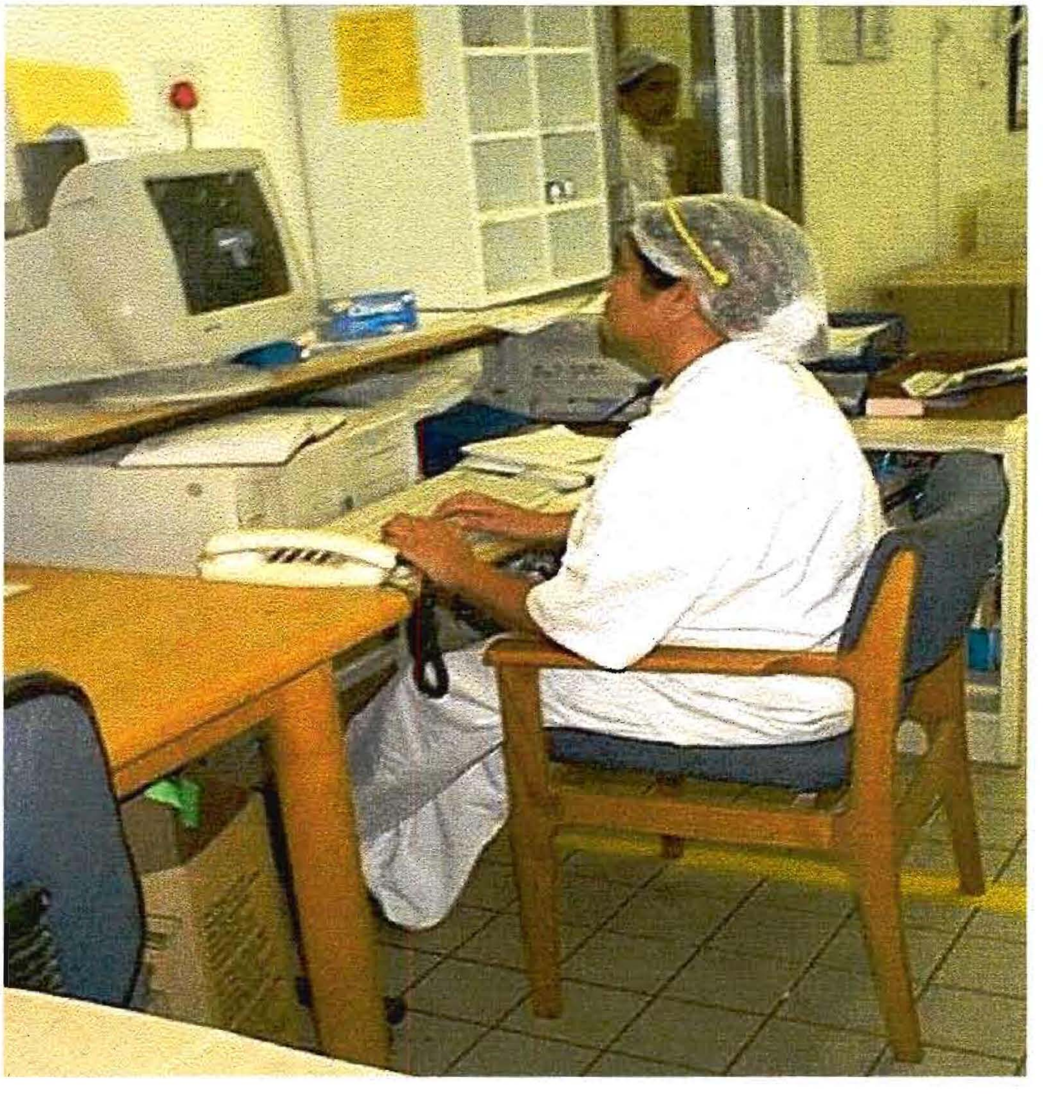


Fig 10 Armrests are too far apart, lack of adjustability of chair, eye line lower than the top of the screen and insufficient desk top space for correct placement of keyboard

4.9.3 Alternative keyboards (Fig 11 a, b, c & d)

Alternative keyboard designs have yet to be proved to reduce injury. Further research is necessary before these designs can be recommended.

"Split keyboards" are designed to straighten the wrist, by splitting and rotating each half of the keyboard, the keys are aligned with the forearm (Fig 11a)

"Tented keyboards" are a modification of the split keyboard, tilting the two halves up like a tent reduces the amount of rotation of the forearms (Fig 11b)

Some keyboard designs have tried to accommodate the fingers by curving the rows of keys or placing them in a concave well allowing the fingers to operate in a more relaxed position (Fig 11c & 11d)

4.9.4 Mouse

Some ergonomists assert that the mouse is more inclined than the keyboard to cause injury due to the way it is used: gripping it tightly with static muscular force and repetitive clicking of the control key. (Fig 3)

The mouse should be accommodated on the same level and in close proximity to the keyboard, reducing abduction of the upper arm whilst operating it. Operators should be trained to keep their wrist in a neutral position and apply as little force as possible when clicking or dragging with the mouse.

Figure 11a Split and rotated keyboard with wrist rest

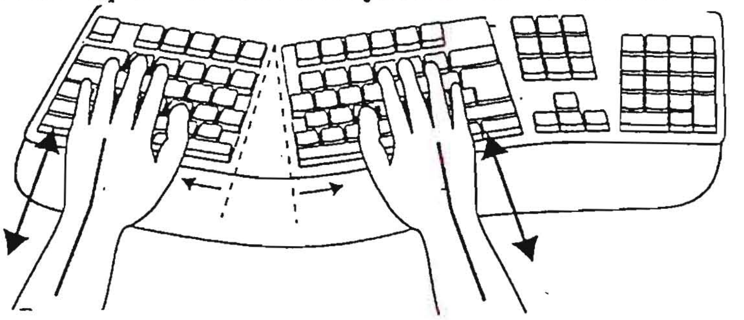


Figure 11b Split and tented keyboard

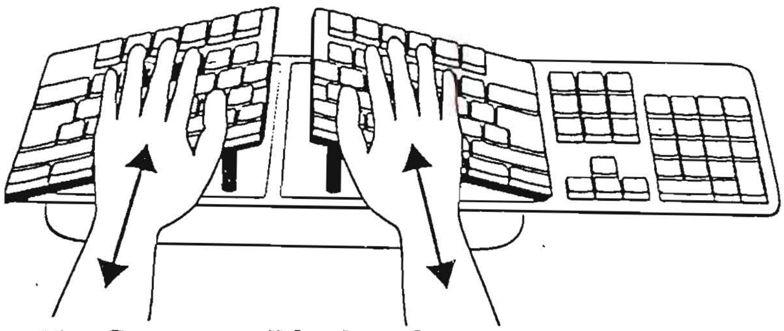


Figure 11c Concave well keyboard

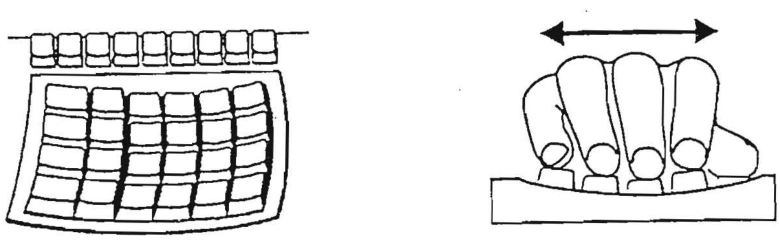
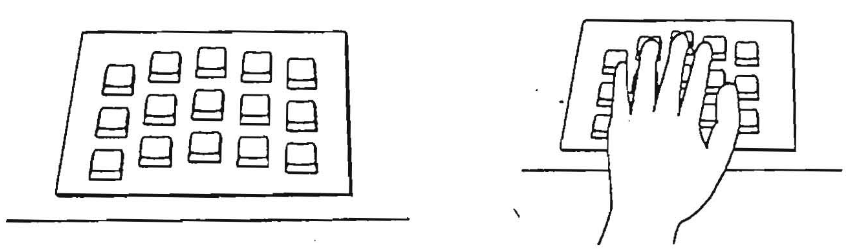


Figure 11d Curved keyboard



(Drawings courtesy of the National Institute for Occupational Safety and Health, Alternative Keyboards)

4.9.5 Multitasking:

VDT operators in the course of their work often use the keyboard in conjunction with other instruments e.g. telephone or multiple video screens (Fig. 3, 6, 8, 12 & 13)). Holding the telephone squeezed between the laterally flexed neck and the raised shoulder limits the use of the arms therefore placing more strain on the wrists, predisposing operators to wrist, forearm, neck and shoulder disorders (Fig 12 & 13). A telephone headset is recommended in order to free-up the hands and prevent the malpositioning of the neck and shoulders.

Figure 12 Multitasking: telephone receiver held clamped between neck and shoulder, screen at right angles to the keyboard. Mouse too far from keyboard resulting in the abduction of operators right arm.

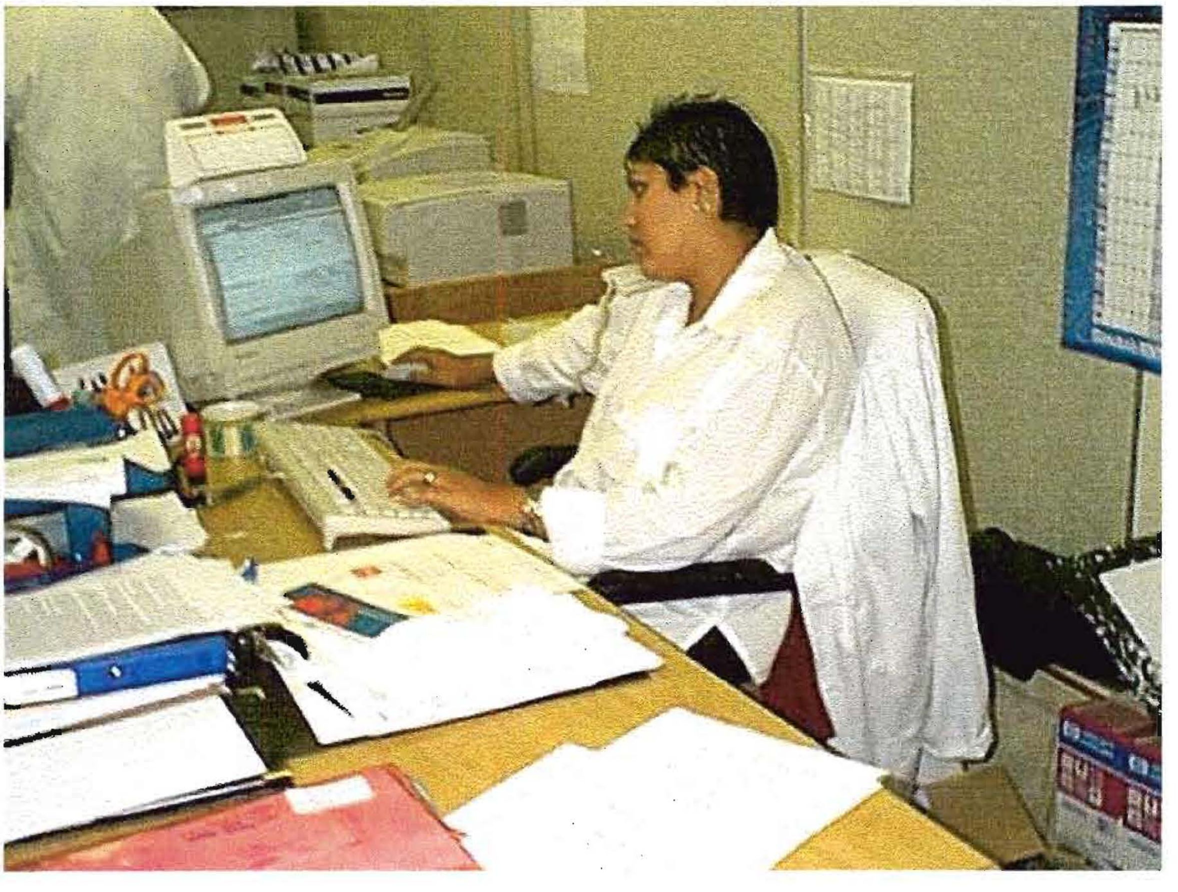
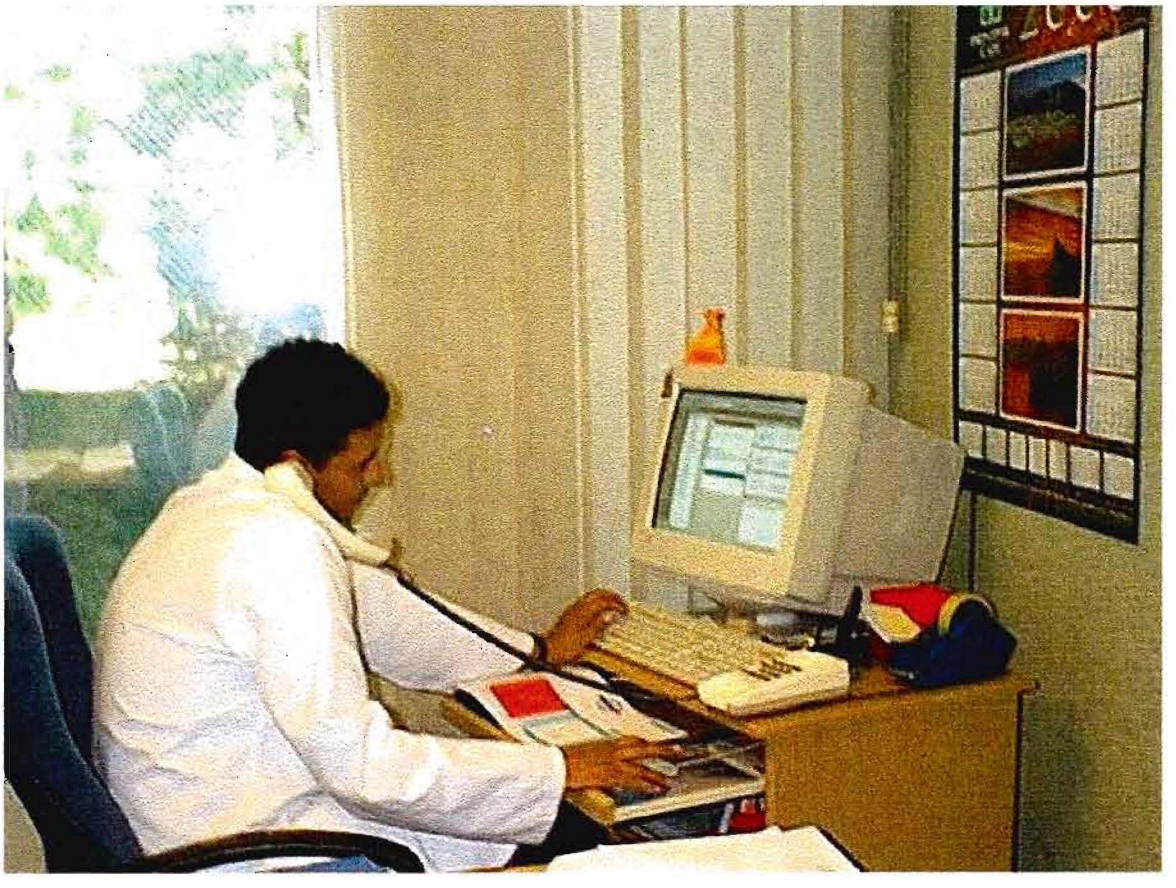


Figure 13 Multitasking: telephone receiver held clamped between neck and shoulder whilst operating keyboard. Insufficient desktop space for placement of hardcopy.



4.10 WORK STRESS IN VDT OPERATORS

Ergonomic design factors of video display terminals have been the focus of much research but little attention has been paid to "job design factors" that may contribute to psychological job stress. There is an increasing realization that psychosocial factors play a significant role in the overall work situation.

In "Ergonomic aspects of visual display terminals", edited by Grandjean and Vigliani, published by Taylor and Francis (1983), Smith et al. in their paper, "Job stress in video display operations" (Section 6, pg. 201), found that high job demands produced increased stress levels and health complaints. It is therefore concluded that ergonomic solutions to improve operator's health should not only deal with the physical workstation but also with the "job task demands". It was found that even though some operator had high production demands and tight deadlines they complained less about job demands if they were given increased independence and flexibility.

In order to protect the health of the worker, ergonomic solutions dealing with the workstation should be supplemented by proper job task design. For example an increase in task variety, improvement of job organization and introduction of rest breaks.

5 MATERIALS AND METHODS

5.1 AIM

To establish the effect of ergonomic training on visual display terminal operators.

5.2 CRITERIA FOR EFFECTIVENESS

5.2.1 Implementation of ergonomic changes by the operators.

5.2.2 A decrease in complaints of musculoskeletal and visual discomforts after implementation of the ergonomic changes to the operator's workstations.

5.3 HYPOTHESIS

Training of VDT operators is effective.

5.4 SAMPLING METHOD

Forty-eight VDT operators were randomly recruited from amongst the VDT operators employed at Warner-Lambert, Cape Town. The VDT operators were then randomly assigned to either the experimental group or the control group.

5.5 METHOD

5.5.1 An ergonomic survey is a structured and systematic method of recognizing risk factors and uncovering the causes of the observed deficiencies in the workplace. The researcher, using an Ergonomic Checklist (Appendix 5), conducted an ergonomic survey of the workstations used by 48 randomly chosen VDT operators working at Warner-Lambert, Cape Town. The data and information gathered during this survey was obtained through measuring furniture dimensions and physical parameters of the environment as well as the completion of the questions by means of an interview conducted by the researcher. Completion of the assessment by a single researcher minimizes variation in criteria adopted for a subjective assessment but does introduce the possibility of a consistent bias in the data. Photographs were taken depicting the ergonomic layout of a representative sample of these workstations.

5.5.2 The completion of a questionnaire, "Symptom survey" adapted from a Nordic Questionnaire, (Department of Occupational Medicine, Sweden, Wilson & Corlett, 1991), (Appendix 3) by 48 randomly chosen VDT operators, to ascertain the type and severity of the health complaints associated with VDT work. The researcher visited each VDT operator individually and assisted the operator in completing the “Symptom survey” (Appendix 3) questionnaire.

5.5.3 Twenty-five randomly selected VDT operators (experimental group) were trained in the development of ergonomic self-help skills to enable them to make the necessary ergonomic changes within their workstations. The training was accomplished by means of a lecture (one-hour) about ergonomics at the workplace of VDT operators. The lectures were supplemented by a video (Office Ergonomics, Coastal Training, Learning resource) giving a practical demonstration of how the VDT workstation could be made more ergonomically correct. The outline of the training program is to be found in Appendix 2.

5.5.4 The control group of operators (not received ergonomic training) was compared to the experimental group of operators (had received training) to evaluate the effectiveness of training. The evaluation of the training was done after a three month period by:

(a) Comparison of the prevalence of musculoskeletal disorders pre training by means of a questionnaire "Symptom survey" (Appendix 3) and then three months later operators were interviewed again in order to complete a follow-up "Symptom survey" questionnaire (Appendix 4). The follow-up survey reduced the number of person specific questions and asked questions concerning health complaints in the preceding three months.

(b) Completion of an ergonomic survey, by means of an Ergonomic Checklist (Appendix 5), pre and post training in order to establish whether operators had improved the ergonomics of their workstations.

(c) The "Symptom survey" questionnaires (Appendix 3), the follow-up "Symptom survey" (Appendix 4) and the ergonomic survey, by means of the Ergonomic Checklist (Appendix 5) were administered to the VDT operators in the control group at the same time as the experimental group.

5.5.5 Data analysis (Epi Info Program and Statistica):

(a) A comparison of the number of workstation changes made by each operator in both the experimental and the control group by means of the Wilcoxon Sum Rank Test.

(b) The Chi-squared test was used to test for the association between receiving ergonomic training and making ergonomic changes

(c) The Spearman Rank Order Correlation test was performed to determine if there was an association between the number of ergonomic problems and the number of musculoskeletal disorders and if there was a correlation between the number of musculoskeletal problems and the number of changes made in the workplace.

(d) Comparison of the type of changes made by each operator in both the experimental and the control group

(e) Comparison of the number of pain sites (musculoskeletal pain) suffered by the control group versus the experimental group before and after training of the experimental group

5.5.6 Inclusion and exclusion criteria

(a) Subjects were included in the study if they operated a VDT for an average of four (4) or more hours per day.

(b) Subjects were excluded from the study if they suffered from thyroid or rheumatoid problems.

(c) Deficiencies in eyesight were not a significant factor as Warner-Lambert conducts annual eye tests and any operators suffering from deficient visual acuity are referred for corrective prescriptive treatment.

5.6 ASSUMPTIONS

5.6.1 It was assumed that the operators would be willing to co-operate in the ergonomic improvement of the workstations.

It was assumed that the subjects would adhere to the following:

5.6.2 To answer the questionnaire honestly and to the best of their ability.

5.6.3 To implement ergonomic changes in accordance with ergonomic principles as laid out in the training course.

5.7 LIMITS OF STUDY

5.7.1 This study was completed before any of the information technologists or department managers had been trained.

5.7.2 The group size of forty-eight (48) was limiting for statistical analysis.

5.7.3 This study did not take into account the different stages of changes in behaviour.

5.7.4 During the study colleagues may have begun or alternatively may have stopped using treatment for MSDs.

5.7.5 During the time period in which this research project was conducted the amount of absenteeism was negligible and therefore no inferences were deduced therefrom.

5.7.6 All VDT operators were from Warner-Lambert, Cape Town and therefore the possibility exists that the experimental and control groups could have come into contact with each other and influenced the outcome of the study.

5.7.7 The "Hawthorne effect" (Dictionary of Psychology, pg. 317) cannot be excluded when comparing the results of the control group and the experimental group. When management introduces a new program showing an interest in the well being of their employees this can often stimulate improved performance and worker satisfaction. The "Hawthorne effect" could therefore result in a reduction in the differences between the behaviour of the control group and experimental group.

5.8 SAMPLE STUDIED

This study consisted of forty-eight (48) operators, twenty-three (23) in the control group (no training received) and twenty-five (25) in the experimental group (training received).

The target sample of this study was VDT operators who used their terminals for a minimum of four hours per day.

The mean age of the operators was thirty-eight (38) years (Table 1), with a range of 22-58 years. The mean number of year experience was 8,23 years (Table 1) with a range of 1-24 years. The mean number of hours operating a VDT was 6 hours (Table 1) with a range of 4-8 hours. There was no significant difference between the mean ages, mean years of experience or mean number of hours worked per day in the control and experimental groups.

The operators' job titles fell into three categories, 28 administrative staff, 6 managers and 14 personal assistants (Table 3). 39 of the operators were females and 9 were males (Table 4).

TABLE 1 AGE, EXPERIENCE AND OPERATING HOURS PER DAY

	Total sample (n=48)		Experimental group (n=25)		Control group (n=23)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Age (yrs)	38,85	±9,62	40,24	±10,21	37,35	±8,91
Experience (yrs)	8,23	±5,28	8,56	±5,76	7,87	±4,80
Hours per day	6,00	±1,41	5,92	±1,35	6,09	±1,51

TABLE 2 TEST FOR SIGNIFICANCE BETWEEN MEAN AGES OF TWO GROUPS

Training	Number	Mean	Range of age
No	23	37,35	25-58
Yes	25	40,24	22-58
Wilcoxon Two-Sample test..................p=0,341955			

The Wilcoxon Two-Sample Test was performed to test for any significant difference between the mean ages of the two groups. The above results show no significant difference (p>0,05) between the ages of the two groups.

TABLE 3 JOB TITLES

	Total sample	Experimental group	Control group
Managers	6 (12,5%)	2 (8%)	4 (17,4%)
Administrators	28 (58,3%)	15 (60%)	13 (56,5%)
Personal assistants	14 (29,2%)	8 (32%)	6 (26,1%)
Total	48 (100%)	25 (100%)	23 (100%)

TABLE 4 THE GENDER OF OPERATORS

	Total sample	Experimental group	Control group
Females	39 (81,3%)	21 (84,0%)	18 (78,3%)
Males	9 (18,8%)	4 (16,0%)	5 (21,7%)
Total	48 (100%)	25 (100%)	23 (100%)

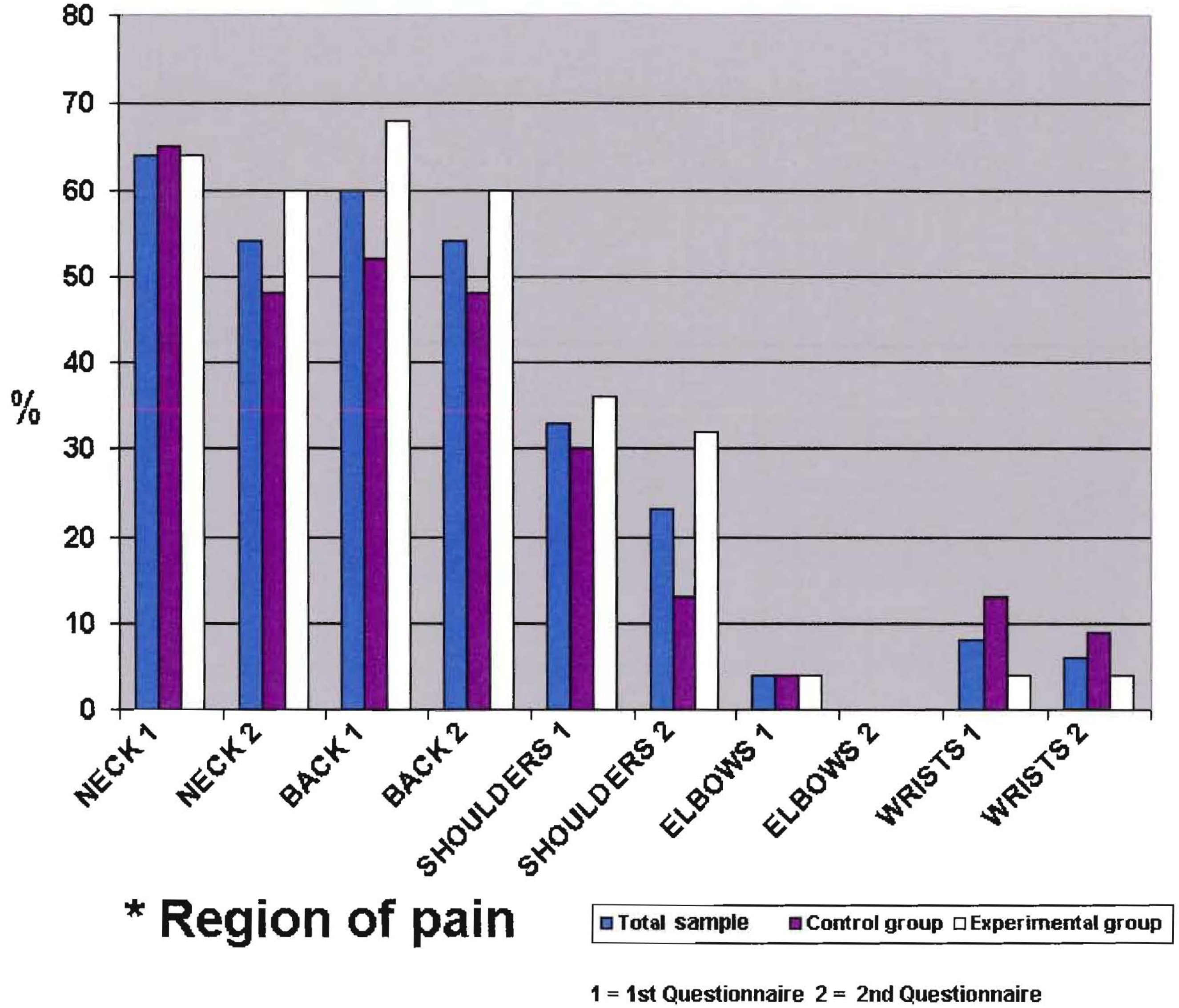
6 RESULTS

6.1 RESULTS OF THE QUESTIONNAIRE RELATING TO MUSCULOSKELETAL DISORDERS

TABLE 5 NUMBER OF PAIN SITES

Region of pain	Number of pain sites in the total sample n=48		Number of pain sites in the experimental group n=25		Number of pain sites in the control group n=23	
	1st Questionnaire	2nd Questionnaire	1st Questionnaire	2nd Questionnaire	1st Questionnaire	2nd Questionnaire
Neck	31 (64,58%)	26 (54,2%)	16 (64%)	15 (60%)	15 (65,22%)	11 (47,8%)
Back	29 (60,4%	26 (54,2%)	17 (68%)	15 (60%)	12 (52,17%)	11 (47,8%)
Shoulder	16 (33,3%)	11 (22,9%)	9 (36%)	8 (32%)	7 (30,43%)	3 (13%)
Elbow	2 (4,16%)	0 (0%)	1 (4%)	0 (0%)	1 (4,35%)	0 (0%)
Wrist	4 (8,33%)	3 (6,3%)	1 (4%)	1 (4%)	3 (13,04%)	2 (8,7%)
Total no. of pain sites	82	66	44	39	38	27

FIG. 14
OPERATORS SUFFERING FROM MUSCULOSKELETAL DISORDERS (n=48)



6.1.1 Operators suffering from musculoskeletal disorders (Table 5 & Fig 14)

In the control group there was a decrease in the number of pain sites from 38 to27 (a relative decrease of 28,9%) and in the experimental group there was a decrease in pain sites from 44 to 39 (a relative decrease of 11,4%). The results show that there was a larger decrease in the number of pain sites in the control group than in the experimental group therefore ergonomic training alone did not serve to decrease the number of pain sites in operators. The largest decrease in the number of pain sites was in neck disorders of the control group (4) and back disorders of the experimental group (2).

6.1.2 Operators suffering from musculoskeletal disorders before intervention (1ST Questionnaire) and after intervention (2nd Questionnaire)

TABLE 6a TOTAL SAMPLE: OPERATORS WITH MSDs

Total sample (n=48)			
1st Questionnaire		2nd Questionnaire	
Musculoskeletal disorders	No musculoskeletal disorders	Musculoskeletal disorders	No musculoskeletal Disorders
38 (79,2%)	10 (20,8%)	35 (72,9%)	13 (27,1%)

TABLE 6b EXPERIMENTAL GROUP: OPERATORS WITH M.S.D's

Experimental group (n=25)			
1st Questionnaire		2nd Questionnaire	
Musculoskeletal disorders	No musculoskeletal disorders	Musculoskeletal disorders	No musculoskeletal disorders
21 (84%)	4 (16%)	20 (80%)	5 (20%)

TABLE 6c CONTROL GROUP: OPERATORS WITH M.S.D's

Control group (n=23)			
1st Questionnaire		2nd Questionnaire	
Musculoskeletal disorders	No musculoskeletal Disorders	Musculoskeletal disorders	No musculoskeletal disorders
17 (73,9%)	6 (26,1%)	15 (65,2%)	8 (34,8%)

6.1.3 Results of operators suffering from musculoskeletal disorders before intervention (1ST Questionnaire) and after intervention (2nd Questionnaire)

The results show that in the total population there was a 6,3% decrease in the number of operators suffering from musculoskeletal complaints, with a 4% decrease in the experimental group and an 8,7% decrease in the control group (Table 6a,b & c).

6.1.4 Types and number of musculoskeletal disorders that received treatment (1st Questionnaire)

TABLE 7a TOTAL SAMPLE: NUMBER OF DISORDERS THAT RECEIVED TREATMENT (n=48)

Type of MSD	Number of disorder in total sample	Total number of disorders that received treatment	Total number of disorders that did not received treatment
Neck trouble	31 (38%)	18 (58%)	13 (42%)
Back trouble	29 (35%)	10 (35%)	19 (65%)
Shoulder trouble	16 (20%)	9 (56%)	7 (44%)
Elbow trouble	2 (2%)	0	2 (100%)
Wrist trouble	4(5%)	1 (25%)	3 (75%)
Total number of disorders	82 (100%)	38 (46%)	44 (54%)

TABLE 7b EXPERIMENTAL GROUP: NUMBER OF DISORDERS THAT RECEIVED TREATMENT (n=25)

Type of MSD	Number of disorders in experimental group	Disorders in the experimental group that received treatment	Disorders in the experimental group that did not receive treatment
Neck trouble	16 (37%)	9 (56%)	7 (44%)
Back trouble	17 (39%)	6 (35%)	11 (65%)
Shoulder trouble	9 (20%)	5 (56%)	4 (44%)
Elbow trouble	1 (2%)	0	1 (100%)
Wrist trouble	1 (2%)	0	1 (100%)
Total number of disorders in experimental group	44 (100%)	20 (45%)	24 (55%)

TABLE 7c CONTROL GROUP: NUMBER OF DISORDERS THAT RECEIVED TREATMENT (n=23)

Type of MSD	Number of disorders in the control group	Number of disorders in the control group that received treatment	Number of disorders in the control group that did not receive treatment
Neck trouble	15 (39%)	9 (60%)	6 (40%)
Back trouble	12 (32%)	4 (33%)	8 (67%)
Shoulder trouble	7 (18%)	4 (57%)	3 (43%)
Elbow trouble	1 (3%)	0	1 (100%)
Wrist trouble	3 (8%)	1 (33%)	2 (67%)
Total number of disorders in the control group	38 (100%)	18 (47%)	20 (53%)

6.1.5 Type of treatment that operators suffering from MSDs sought (1st Questionnaire) (n=48)

TABLE 8a TYPE OF TREATMENT SOUGHT FOR MSDs

Type of treatment	Neck Trouble	Back trouble	Shoulder trouble	Elbow trouble	Wrist trouble	Total
Medication	5 (16%)	8 (28%)	6 (38%)	-	1 (25%)	20
Physiotherapy	1 (3%)	1 (3%)	-	-	-	2
Massage	2 (6%)	-	-	-	-	2
Medication and massage	2 (6%)	-	-	-	-	2
Chiropractic	3 (10%)	-	-	-	-	3
Aromatherapy	2 (7%)	-	1 (6%)	-	-	3
Orthotics and physiotherapy	2 (7%)	-	-	-	-	2
Physiotherapy and medication	1 (3%)	1 (3%)	2 (12%)	-	-	4
No treatment	13 (42%)	19(66%)	7 (44%)	2 (100%)	3 (75%)	44
Total no. of complaints	31 (100%)	29 (100%)	16 (100%)	2 (100%)	4 (100%)	82

TABLE 8b TYPE OF TREATMENT SOUGHT FOR MSDs

DIVIDED INTO THE EXPERIMENTAL (n=25) AND CONTROL GROUP (n=23)

(1st Questionnaire)l

Type of treatment	Neck Trouble		Back trouble		Shoulder trouble		Elbow trouble		Wrist trouble	
	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont
Medi-Cation	3 19%	2 13%	5 29%	3 25%	4 44%	2 29%	-	-	-	1 33%
Physio-therapy	-	1 7%	-	1 8%	-	-		-	-	-
Massage	1 6%	1 7%	-	-	-	-	-	-	-	-
Medi-cation and massage	1 6%	1 7%	-	-	-	-	-	-	-	-
Chiro-practic	3 19%	-	-	-	-	-	-	-	-	-
Aroma-therapy	-	2 7%	-	-	-	1 14%	-	-	-	-
Orthotics and physio-therapy	1 6%	1 7%	-	-	-	-	-	-	-	-
Physio-therapy and medi-cation	-	1 7%	1 6%	-	1 11%	1 14%	-	-	-	-
No treatment	7 44%	6 40%	11 65%	8 67%	4 44%	3 43%	1 100%	1 100%	1 100%	2 67%
Total no. of com-plaints	16 100%	15 100%	17 100%	12 100%	9 100%	7 100%	1 100%	1 100%	1 100%	3 100%

*Exp=Experimental group / Cont=Control Group

6.1.6 Results related to the type of treatment that operators sought (Table 8a & 8b)

The results showed that 46% of MSDs received treatment and that the majority of disorders were treated with the use of medication (24%) or a combination of medication and physiotherapy (5%). Out of a total of thirty-eight (38) MSDs treated, 47% were disorders of the neck. The results showed that there was no significant difference between the type of treatment sought by each group.

6.1.7 Severity of musculoskeletal disorders

TABLE 9 MEAN AND STD DEV OF THE SEVERITY RATE OF MUSCULOSKELETAL DISORDERS BEFORE INTERVENTION

Type of musculoskeletal Trouble	Mean and standard deviation of the musculoskeletal pain severity rating*					
	Total sample		Experimental group		Control group	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Neck trouble	4,94	±1,59	4,63	±1,26	5,27	±1,87
Back trouble	5,25	±2,08	5	±1,86	5,58	±2,39
Shoulder trouble	5,06	±1,77	4,78	±1,72	5,43	±1,9
Elbow trouble	5,5	±2,12	4	0	7	0
Wrist trouble	6	±2	7	0	5,33	±2,31

* Severity of pain was measured on a scale of 1-10, 1 = No pain, 10 = Maximal pain

TABLE 10 MEAN SEVERITY RATING BEFORE AND AFTER INTERVENTION

Type of musculo-skeletal trouble	Mean severity pain rating *					
	Total sample		Experimental group		Control group	
	1st Question-naire	2nd Question-naire	1st Question-naire	2nd Question-naire	1st Question-naire	2nd Question-naire
Neck trouble	4,94	4,31	4,63	4	5,27	4,73
Back trouble	5,25	4,84	5	4,21	5,58	5,26
Shoulder trouble	5,06	3,91	4,78	3,38	5,43	5,33
Elbow trouble	5,5	-	4	-	7	-
Wrist trouble	6	5	7	3	5,33	6
Total musculo-Skeletal trouble	5,35	4,52	5,08	3,65	5,91	5,33

- Severity of pain was measured on a scale of 1-10, 1 = No pain, 10 = Maximal pain

6.1.8 Results of the severity rating (Table 10)

The results show that in the total population there was a 0,83 mean decrease in the severity rating of musculoskeletal disorder, the experimental group had a mean decrease of 1,43 and the control group has a mean decrease of 0,58. This shows a significantly larger decrease for the experimental group's mean severity rating. As there was no significant difference in the treatment sought, this may be indicative of the positive results of the training program.

6.1.9 Reasons for musculoskeletal disorders

TABLE 11a OPERATORS REPORTED REASON FOR THEIR MUSCULOSKELETAL TROUBLE: TOTAL SAMPLE (n=48)

		Location of musculoskeletal disorder				
Cause of musculoskeletal problem	Total	Neck trouble	Back trouble	Shoulder trouble	Elbow Trouble	Wrist trouble
Work posture	44(54%)	13 (42%)	20 (69%)	8 (50%)	1 (50%)	2 (50%)
Draught at work	1(1%)	1 (3%)	-	-	-	-
Injury	3(4%)	1 (3%)	2 (7%)	-	-	-
Injury aggravated by work	3(4%)	1 (3%)	2 (7%)	-	-	-
Work posture and stress	14(17%)	9 (29%)	1 (3%)	4 (25%)	-	-
Unknown	17(20%)	6 (20%)	4 (14%)	4 (25%)	1 (50%)	2 (50%)
Total	82 (100%)	31 (100%)	29 (100%)	16 (100%)	2 (100%)	4 (100%)

TABLE 11b OPERATORS REPORTED REASON FOR THEIR MUSCULOSKELETAL TROUBLE

EXPERIMENTAL GROUP (n=25), VERSUS CONTROL GROUP (n=23)

Cause	Neck trouble		Back trouble		Shoulder Trouble		Elbow Trouble		Wrist trouble	
	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont	Exp	Cont
Work posture	7 (44%)	6 (40%)	13 (76%)	7 (58%)	4 (44%)	4 (57%)	-	1 (100%)	1 (100%)	1 (33%)
Draught at work	-	1 (7%)	-	-	-	-	-	-	-	-
Injury	1 (6%)	-	1 (6%)	1 (8%)	1 (11%)	-	-	-	-	-
Injury aggrav-ated by work	1 (6%)	-	1 (6%)	1 (8%)	-	-	-	-	-	-
Work and stress	3 (19%)	6 (40%)	-	1 (8%)	1 (11%)	2 (29%)	-	-	-	-
Un-known	4 (25%)	2 (13%)	2 (12%)	2 (17%)	3 (33%)	1 (14%)	1 (100%)	-	-	2 (67%)
Total	16 (100%)	15 (100%)	17 (100%)	12 (100%)	9 (100%)	7 (100%)	1 (100%)	1 (100%)	1 (100%)	3 (100%)

*Exp=Experimental group / Cont=Control Group

6.1.10 Results of the reported reasons for musculoskeletal trouble (Table 11a & b)

VDT operators have linked the cause of the majority of MSDs to their work postures (54%) and to a lesser degree the combination of work postures and stress (17%). Operators identified 42% of their neck troubles as having resulted from work posture and 29% resulting from a combination of work posture and stress. The operators could not identify the causes of 20% of the MSDs.

6.1.11 Mean amount of time employees had suffered from a musculoskeletal problem

TABLE 12 MEAN AMOUNT OF TIME EMPLOYEES HAD SUFFERED FROM A MUSCULOSKELETAL PROBLEM

Type of musculo -skeletal disorder	Mean amount of time in years employees had suffered from a musculoskeletal problem					
	Total sample (n=48)		Experimental group (n=25)		Control group (n=23)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Neck trouble	3,06	±2,82	3,48	±2,92	2,62	±2,74
Back trouble	5,93	±5,01	5,77	±4,6	6,17	±5,74
Shoulder trouble	3,36	±3,08	2,93	±3,14	3,93	±3,14
Elbow trouble	2,05	±2,76	0,1	0	4	0
Wrist trouble	2,5	±1,29	3	0	2,33	±1,53

6.2 RESULTS RELATING TO EYESTRAIN

TABLE 13 THE MEASUREMENT OF VISUAL DISTANCE (SCREEN TO EYE) SHOWED THE FOLLOWING RESULTS

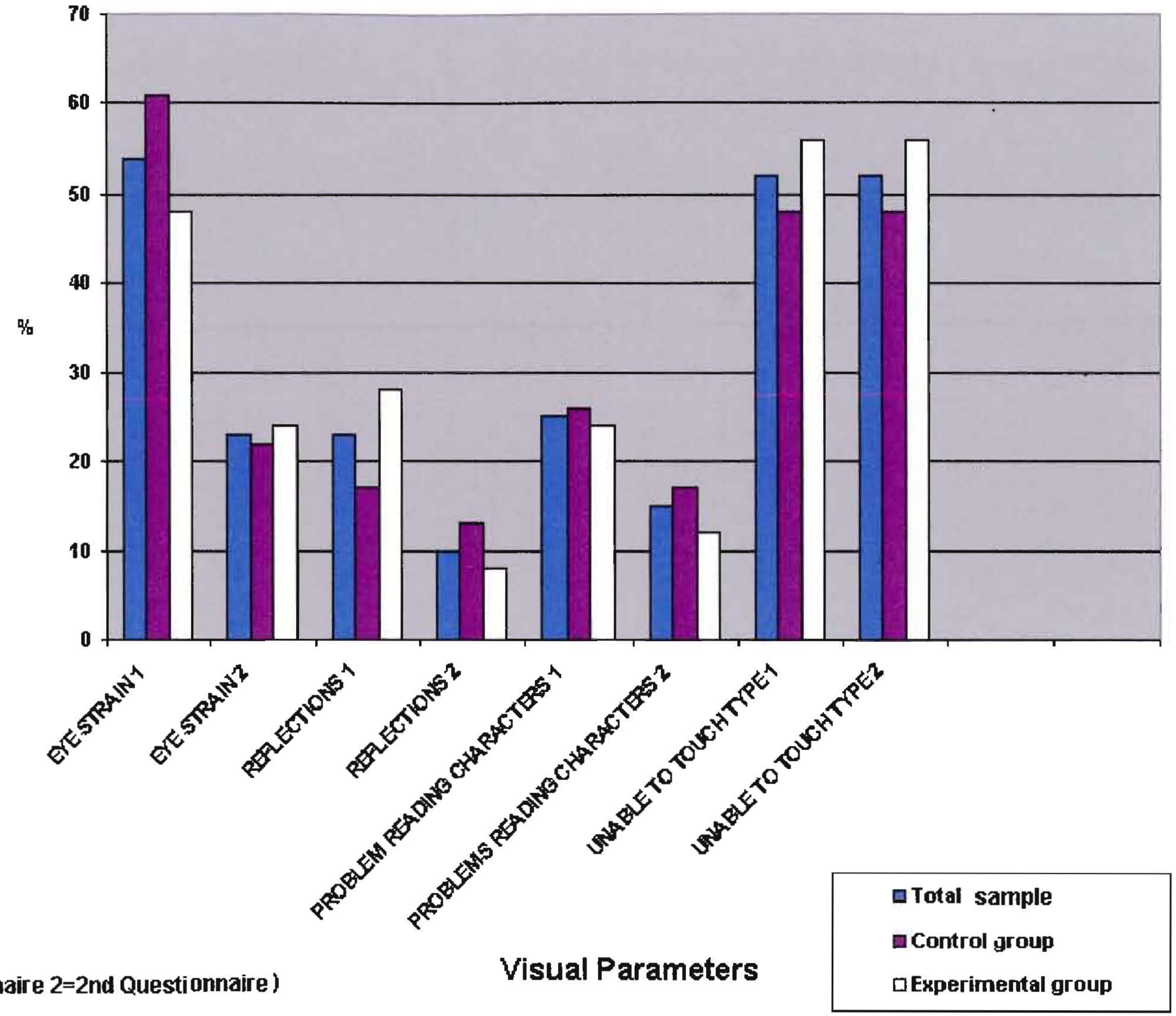
Range	Mean	Std. Dev.	Median
40-90 cm	63,44 cm	±12,47	65cm

The recommended viewing distance (screen to eye) should be a minimum of 70cm (arms length), as any work performed closer than the resting point of convergence will result in eye stress. The results show that the viewing distance of 71% of the operators was less than 70cm, this could result in eyestrain.

TABLE 14 ANALYSIS OF VISUAL PARAMETERS OF VDT WORKSTATIONS

	Total sample (n=48)		Experimental group 1st Question -naire (n=25)	Experimental group 2nd Question -naire (n=25)	Control group 1st Question -naire (n=23)	Control group 2nd Question -naire (n=23)
	Before intervention	After intervention				
No eye strain	22 (45,8%)	37 (77,1%)	13 (52%)	19 (76%)	9 (39,1%)	18 (78,3%)
No screen reflections	37 (77,1%)	43 (89,6%)	18 (72%)	23 (92%)	19 (82,6%)	20 (87%)
No problem reading characters	36 (75%)	41 (85,4%)	19 (76%)	22 (88%)	17 (73,9%)	19 (82,6%)
Able to touch type	23 (47,9%)	23 (47,9%)	11 (44%)	11 (44%)	12 (52,2%)	12 (52,2%)

FIG. 15
VISUAL PARAMETERS OF VDT WORKSTATIONS (n=48)



(1=1st Questionnaire 2=2nd Questionnaire)

TABLE 15 TEST FOR AN ASSOCIATION BETWEEN EYESTRAIN AND ABILITY TO TOUCH TYPE

	Eyestrain		
Touch type	No	Yes	Total
No	13	12	25
Yes	9	14	23
Total	22	26	48

Chi-square = 0,08 P-value = 0,37134074

VDT users who do not touch-type (typing without looking at the keyboard) (52%) are forced to perform more frequent eye movements, focusing changes and head movements. The capacity to touch-type was included as a variable to test the hypothesis that VDT users who were unable to touch-type would have a higher rate of eye discomfort.

The chi-square test was performed in order to test for association between those operators who could touch type and those operators who complained of eyestrain. The above results show no significant association ($p>0,05$) between those operators who could touch type and those operators who complained of eyestrain. The chi-square test was repeated to test for an association between not being able to touch type and neck pain, the results showed no significant association ($p>0,05$).

TABLE 16 TEST FOR ASSOCIATION BETWEEN EYESTRAIN AND NECK TROUBLE

	Neck trouble		
Eyestrain	No	Yes	Total
No	10	12	22
Yes	7	19	26
Total	17	31	48

Chi-square = 1,79 P-value = 0,18102998

Research has shown that operators adopt awkward postures in order to compensate for difficulty in viewing a VDT screen. Lie and Watten (1993) also found that accommodation and convergence of the eye, resulting from prolonged close visual work increases the tension in the muscles of the upper body.

The chi-square test was performed in order to test for association between those operators who suffered neck trouble and those operators who complained of eyestrain. The above results show no significant association (p>0,05) between those operators who suffered from neck trouble and those operators who complained of eyestrain.

TABLE 17 TEST FOR ASSOCIATION BETWEEN AGE AND EYESTRAIN

Results of the Wilcoxon Two-sample test, testing for the association between age and eyestrain

Eyestrain	Number	Median age	Range of age
No	22	36	26-58
Yes	26	37	22-58
Wilcoxon Two-Sample test..................p=0,9553			

People over the age of forty (40) years begin to lose their ability to focus at close distances. Presbyopia, (decrease in the accommodation of the lens of the eye due to loss of elasticity of the lens in aging), results in the eye only being able to focus at a fixed distance. This together with a decrease in the ability to deal with glare could result in increased eyestrain. The Wilcoxon Two-Sample Test was performed to test for the association between age and eyestrain. The above results show no significant association ($p>0,05$) between age and complaints of eyestrain.

TABLE 18 TEST FOR ASSOCIATION BETWEEN THE NUMBER HOURS VDT OPERATION AND EYESTRAIN

Results of the Wilcoxon Two-sample test, testing for the association between the number of hours of VDT operation per day and eyestrain

Eyestrain	Number	Median no. hours	Range of hours
No	22	6	4-8
Yes	26	6	4-8
Wilcoxon Two-Sample test..................p=0,567360			

Gunnarsson et al. (1983) found that daily exposure of long duration was associated with an increase of visual strain in VDT work.

The Wilcoxon Two-Sample Test was performed to test for the association between number of hours of VDT operation per day and eyestrain. The above results show no significant association (p>0,05) between number of hours of VDT operation per day and complaints of eyestrain.

TABLE 19 TEST FOR ASSOCIATION BETWEEN YEARS OF WORK EXPOSURE TO VDTs AND EYESTRAIN

Results of the Wilcoxon Two-sample test, testing for the association between years of work exposure to VDTs and eyestrain

Eyestrain	Number	Median	Range of years of experience
No	22	7,5	1-15
Yes	26	10,0	1-24
Wilcoxon Two-Sample test..................p=0,386912			

Watten et al. (1990) in his study of visual fatigue in VDT work found that prolonged VDT work lead to a number of harmful changes in visual performance and to frequent complaints of visual discomfort and musculoskeletal symptoms.

The Wilcoxon Two-Sample Test was performed to test for the association between years of work exposure to VDT's and eyestrain. The above results show no significant association ($p>0,05$) between years of work exposure and complaints of eyestrain.

TABLE 20 TEST FOR THE ASSOCIATION BETWEEN EYESTRAIN AND DIFFICULTY IN READING CHARACTERS

	Eyestrain		
Difficulty in reading characters	No	Yes	Total
No	19	17	36
Yes	3	9	12
Total	22	26	48

Chi-square = 2,80 P-value = 0,09442892

The chi-square test was performed in order to test for association between those operators who had difficulty read characters on the screen and those operators who complained of eyestrain. The above results showed no significant association (p>0,05) between those operators who had difficulty reading the characters and those operators who complained of eyestrain.

TABLE 21 TEST FOR THE ASSOCIATION BETWEEN EYESTRAIN AND REFLECTIONS ON THE SCREEN

	Eyestrain		
Reflections on screen	No	Yes	Total
No	22	15	37
Yes	0	11	11
Total	22	26	48

Chi-square = 12,07 P-value = 0,00051107

Reflection on the VDT screen decreases the visibility of text on the screen by decreasing the contrast; this can result in eye fatigue. The chi-square test was performed in order to test for association between those operators who had problems with reflections on the screen and those operators who complained of eyestrain. The above results showed a significant association ($p<0,05$) between those operators who had problems with reflections on their screen and those operators who complained of eyestrain.

6.2.1 Results of the questionnaire relating to eyestrain (Table 14 &22, Fig 15)

The results of the questionnaire show that 54,2% of operators suffered from eyestrain, possibly due to difficulty in reading the characters (25%) or problems with screen reflections (22,9%). These problems are aggravated by the poor placement of screens (45,8%), screens positioned too high or too low (89,6%) or incorrect viewing distance (less than 70cm), (71%).

Table 14 shows a large reduction of eyestrain, 39,2% in the control group and 24% in the experimental group, over a three-month period. This large reduction could be attributed to the fact that there were a large number of co-incidental changes in work location in the control group (Table 30). The only empirical conclusion was that the changes in the work location of the operators resulted in a reduction in the intensity of the light and that this lead to a reduction in glare and consequently resulted in the reduction of eyestrain.

6.3 VIDEO DISPLAY TERMINAL WORKSTATIONS

TABLE 22 RESULTS OF THE ERGONOMIC ASSESSMENT

	Total sample (n=48)		Experimental group, 1st Question -naire (n=25)	Experimental group, 2nd Question -naire (n=25)	Control group, 1st Question-naire (n=23)	Control group, 2nd Ques-tionnaire (n=23)
	Before inter-vention	After inter-vention				
Work space satisfaction	25 (52,1%)	29 (60,4%)	10 (40%)	13 (52%)	15 (65,2%)	16 (69,6%)
No operating difficulty	33 (68,8%)	33 (68,8%)	16 (64%)	16 (64%)	17 (73,9%)	17 (73,9%)
Satisfac-tion with chair	18 (37,5%)	28 (58,3%)	8 (32%)	15 (60%)	10 (43,5%)	13 (56,5%)
Eyes level with top of screen	5 (10,4%)	18 (37,5%)	2 (8%)	12 (48%)	3 (13%)	6 (26,1%)
Elbows level with home row Of keys	8 (16,7%)	17 (35,4%)	4 (16%)	12 (48%)	4 (17,4%)	5 (21,7%)
Sufficient leg room	35 (72,9%)	38 (79,2%)	20 (80%)	22 (88%)	15 (65,2%)	16 (69,6%)
Adjustable chairs	35 (72,9%)	42 (87,5%)	19 (76%)	23 (92%)	16 (69,6%)	19 (82,6%)
Seat pan correct depth	39 (81,3%)	39 (81,3%)	20 (80%)	22 (88%)	19 (82,6%)	17 (73,9%)
Good lumbar support	20 (41,7%)	25 (52,1%)	8 (32%)	14 (56%)	12 (52,2%)	11 (47,8%)
Document holder	7 (14,6%)	10 (20,8%)	2 (8%)	3 (12%)	5 (21,7%)	7 (30,4%)
Screen positioned correctly	26 (54,2%)	32 (66,7%)	13 (52%)	18 (72%)	13 (56,5%)	14 (60,9%)

	Total sample (n=48)		Experimental group, 1st Question -naire (n=25)	Experimental group, 2nd Question -naire (n=25)	Control group, 1st Question -naire (n=23)	Control group, 2nd Question -naire (n=23)
	Before inter-vention	After inter-vention				
Mouse positioned Correctly	42 (87,5%)	43 (89,6%)	21 (84%)	22 (88%)	21 (91,3%)	21 (91,3%)
Phone not held in neck	24 (50%)	24 (50%)	10 (40%)	10 (40%)	14 (60,9%)	14 (60,9%)

6.3.1 Results of the ergonomic assessment of VDT workstations (Table 22) (n=48)

Workstation layout

The most frequently found fault was assessed to be the lack of adjustability of the workstations. Even when there was some adjustability in the workstation, operators had little knowledge of how the components should be ergonomically arranged. This resulted in the operators being fixed in a non-optimal position, (eyes not level with the top of the screen and elbows not level with the home row of keys), (Fig 2 & 3).

Of the total number of operators 47,9% were dissatisfied with their work space layout. Operators were often placed in corridors with little or no space for storage and insufficient desktop space for placement of their VDT, some desks were as small as 38cm by 54cm. Due to the fact that the working surface heights were not designed for VDT use, 83,3% of the keyboards were not placed at the correct height i.e. the home row level with the operator's elbows. (Fig 2)

For example the screen was often positioned to the side of the operator (Fig 4 & 12), due to insufficient room directly in front of the operator. When the screen was positioned to the side of the operator (45,8%) there was a constant need to twist their neck and trunk in order to view the screen. If the documents are not positioned at the same height and in line with the screen then the operator has to adopt an awkward posture in order to view the document and operate the VDT (Fig 4 & 12). As a result of insufficient desktop space the operators often balance documents on their knees or on adjacent desks.

As a direct result of the training received by the experimental group there was a distinct improvement in the position of the operators in relation to the computer screen and the keyboard. In the experimental group 40% of operators adjusted their eye level in respect of the top of the screen (versus 13,1% in the control group). In the experimental group 20% changed the position of their screens (versus 4,3% in the control group). In the experimental group 32% adjusted the height of their elbows in respect of the keyboard (versus 4,4% in the control group).

Chairs

Out of the total number of operators 62,5% were dissatisfied with their chairs and 58,3% felt that their chairs did not give adequate lumbar support. Even though the majority of the chairs (72,9%) were adjustable, most of the chairs required the operator to get off the chair and exert considerable force on a knurled knob in order to adjust the height of the seat pan. Chairs were seldom adjusted due to physical difficulties in making adjustments and to lack of knowledge of the adjustability of the chairs. After training operators to adjust their chairs and arrange their workstations in an ergonomically correct way there was an increase in "chair satisfaction" of 28% (versus 13% in the control group), an increase in "work space satisfaction" of 12% (versus 4% in the control group) and improvement in lumbar support of 24% (versus 4,4% in the control group).

Multitasking (Fig 3, 8, 12 & 13)

Fifty percent of operators multitasked; operated their VDT whilst holding the telephone receiver clamped in their neck or wrote or operated two VDT simultaneously. This together with the lack of document holders (85,4%) and the incorrect positioning of the screen could be a major reason for the high incidence of neck troubles (64,4%) (Table 5).

6.3.2 Discussion of workplace findings

It is widely accepted that poor workplace ergonomics can cause chronic musculoskeletal problems. Due to the insidious nature of musculoskeletal problems, operators often tolerate symptoms of these disorders.

The causal relationship between the disorders and the sub-optimal working conditions are seldom recognized by the workers themselves. The results showed that 20% of operators did not know the cause of their musculoskeletal disorder (Table 11a).

The ergonomic assessment of the working environment revealed that the workplaces were inadequately designed (Table 21) and the results of the study showed a high incidence of physical complaints, 79,2% (Table 6a).

The offices being assessed were designed before the arrival of the age of technology. VDTs were installed in the existing offices without any adaptations to the workstations. Employees, many of whom had had no experience in the use or setting up of VDTs, had to adapt themselves to this new innovation. Most VDT workstations comprised an assortment of furniture, which had been brought together haphazardly, with no considered relationship in respect of the equipment, the operator or the tasks to be performed. Working in cramped conditions they often adopt poor postures in order to compensate for the less than optimal ergonomic layout of their workstations

The VDT operator, when faced with more or less fixed equipment moves into an awkward position to compensate for the incompatible man-machine fit, resulting in discomfort, strain and muscle fatigue. This in turn reduces performance, accuracy and speed with the resultant economic repercussions, as the operator is a relatively highly paid skilled worker.

The word "anthropometry" means measurement of the human body. The success of ergonomic design depends on accomplishing a good fit between the measurements of the workspace and the measurements of the users. When designing a workstation the anthropometry of the operator needs to be taken into consideration. Chairs used by the majority of operators were issued to them with no regard for the height of the operator. As a consequence thereof operators who were not of "average size", experienced problems due to the mismatch of the depth (18,8%) (Table 22), and height of the seat pan. This was exacerbated by the lack of footrests for shorter operators. (Fig 7)

The results show that the heaviest restrictions imposed by the workstation components were the eye-screen distance, excessive head movement and incorrect back posture. Therefore the components to be optimized are the chair height and design and the height, width and depth of the work surface.

6.4 WORK PRESSURE EXPERIENCED BY VDT OPERATORS

TABLE 23 WORK PRESSURE AND SETTING WORK PACE

(n=48)

Able to set own work pace	32 (66,7%)	Unable to set own work pace	16 (33,3%)
Do not feel pressurized by work	14 (29,2%)	Feel pressurized by work	34 (70,8%)

6.4.1 Results of the questionnaire relating to work pressure and work pace (n=48) (Table 23)

Results of the questionnaire show that 70,8% of operators felt pressurized by their work and 33,3% were unable to control their work pace (Table 23). This finding was indicative of high stress levels and a feeling of lack of control over work organization.

TABLE 24 TEST FOR THE ASSOCIATION BETWEEN NECK TROUBLE AND PRESSURIZATION AT WORK

	Neck trouble		
Pressure at work	No	Yes	Total
No	6	8	14
Yes	11	23	34
Total	17	31	48

Chi-square = 0,48 p-value = 0,489

Physical stress combines with psychological stress, due to pressure at work, to produce increased levels of musculoskeletal strain. Hence, the use of the chi-square tests to test for association between neck trouble and pressurization at work. The above results show no significant difference ($p>0,05$) between those operators who complained of neck trouble and those operators who felt pressurized by their work.

6.5 NUMBER OF MUSCULOSKELETAL DISORDERS

TABLE 25 PERCENTAGE AND NUMBER OF OPERATORS WHO HAVE A RANGE OF MUSCULOSKELETAL DISORDERS

(n=48)

No. of problems	Total sample (n=48)		Experimental group, 1st Question -naire (n=25)	Experimental group, 2nd Question -naire (n=25)	Control group, 1st Question -naire (n=23)	Control group, 2nd Question -naire (n=23)
	Before inter- vention	After inter- vention				
0	5 (10,4%)	9 (18,8%)	2 (8%)	3 (12%)	3 (13%)	6 (26,1%)
1	12 (25%)	14 (29,2%)	8 (32%)	9 (36%)	4 (17,4%)	5 (21,7%)
2	10 (20,8%)	13 (27,1%)	3 (12%)	4 (16%)	7 (30,4%)	9 (39,1%)
3	12 (25%)	10 (20,8%)	5 (20%)	8 (32%)	7 (30,4%)	2 (8,7%)
4	8 (16,7%)	2 (4,2%)	7 (28%)	1 (4%)	1 (4,3%)	1 (4,3%)
5	1 (2,1%)	0	0	0	1 (4,3%)	0
Total no. of operators with problems	43 (89,6%)	39 (81,3%)	23 (92%)	22 (88%)	20 (86,8%)	17 (73,8%)
Mean and Std dev. of problems	2,19 ±1,33	1,63 ±1,14	2,28 ±1,4	1,8 ±1,16	2,09 ±1,28	1,44 ±1,12

6.5.1 Results of the changes in the number of musculoskeletal disorders (Table 25)

There was a decrease in the mean number of MSDs in both the control group and the experimental group, with only a small decrease of four (4) in the number of operators complaining of MSDs.

There was a significant reduction in the number of musculoskeletal disorders in those colleagues who suffered from four complaints in the experimental group (Table 25). The results show that operators with a larger number of complaints benefited the most from the training.

6.6 DIMENSIONS OF VDT WORKSTATION FURNITURE

TABLE 26 EXISTING FURNITURE DIMENSIONS MEASURED BEFORE INTERVENTION

Dimensions (cm)	Minimum	Maximum	Percentage of dimensions that fell within the range	Standard Dimension for South Africa	Standard dimensions for America
Desk height	55	76	46 (96%) (>66cm and <77cm)	67	76
Desk width	38	99	43 (90%) (> 60cm)	60 minimum	*
Desk length	54	170	16 (33,3%) (> 120cm)	120	*
Seat height	42	67	28 (58%) (>41cm and <53cm)	44 fixed 42-50 adjustable	40-52
Seat width	30	52	35 (73%) (> 40cm)	40 minimum	45 minimum
Seat depth	34	50	19 (40%) (>37cm and <44cm)	38-43	38-43

* Indicated by task

6.6.1 Comparison of existing furniture with standard VDT furniture dimensions (Table 26)

Table 26 shows a large variation between the minimum and maximum dimensions of desk heights (21cm), the minimum of 55cm is 12cm lower than the recommended height for South Africa (S.A.B.S) and 21cm lower than the recommendation for height in America (ANSI). As a result of this large variation in desk height many operators are forced to sit at desks which are below the recommended height. Desks heights cannot be easily altered and it is therefore recommended that desk height accommodate the tallest operator and the shorter operator can then use the adjustability of the chair to adapt to the higher desk.

A minimum desk width of 60cm, as recommended by the South African standards, is the minimum width required if the screen is to be placed at the recommended distance from the eyes. This width needs to be increased to 70cm if there is no space for the back of the screen to protrude over the edge of the back of the desk.

Table 26 shows that the minimum seat width of 30cm is 10cm narrower than the minimum requirement of 40cm. Seat width should always accommodate the wider operator, as chair width is not adjustable.

Table 26 shows that there is a large variation in seat pan depth (16cm) which causes a major problem in that the deeper seats do not accommodate the shorter operator and cannot be adjusted to fit them. Chairs are often allocated without regard for the operators' height as well as the fact that it is difficult to source chairs with a shorter seat pan depth. The majority of chair manufacturers appear to design chairs with the tall male in mind forcing their female counterparts to sit perched on the edge of their chair without being able to take advantage of the lumbar support.

6.7 NUMBER OF ERGONOMIC CHANGES MADE BY OPERATORS

TABLE 27 NUMBER OF ERGONOMIC CHANGES MADE TO WORKSTATIONS, AND COMPARISONS BETWEEN THE EXPERIMENTAL AND CONTROL GROUP

No. of changes made	Total sample (n=48)	Experimental group (n=25)	Control group (n=23)
0	23 (47,9%)	10 (40%)	13 (56,5%)
1	15 (31,3%)	7 (28%)	8 (34,8%)
2	8 (16,7%)	6 (24%)	2 (8,7%)
3	2 (4,2%)	2 (8%)	-
Total	48 (100%)	25 (100%	23 (100%)

6.7.1 Results of number of ergonomic changes made by operators

The results of Table 27 show that twenty-five (25) operators made changes in their workstations, ten (10) in the control group and fifteen (15) in the experimental group. What is significant is that only two (2) operators in the control group make more than one change versus 8 (eight) operators in the experimental group who made two or more changes. This implies that a learning process has taken place in the experimental group.

TABLE 28 NUMBER OF CHANGES MADE, CONTROL GROUP VERSUS EXPERIMENTAL GROUP

Group	Median	Range
Control	0	0-2
Experimental	1	0-3
Wilcoxon Sum Rank test..................p=0,096385		

It was hypothesized that the experimental group, received training, would make more changes than the control group, who had not received training.

The Wilcoxon Sum Test was performed to test for a significant difference between the mean number of changes made by the experimental group (received training) and the control group (no training). The above results show no significant difference ($p>0,05$) between those operators who had received training and those operators who had not received training.

TABLE 29 TEST FOR THE ASSOCIATION BETWEEN RECEIVING ERGONOMIC TRAINING AND MAKING ERGONOMIC CHANGES

Changes in Workstations			
Training	No	Yes	Total
No	13	10	23
Yes	10	15	25
Total	23	25	48

Chi-Square = 1,31 p-value = 0,25235017

A chi-squared test for two categorical variables was performed in order to determine whether there was an association between receiving training and making changes to their workstation. The above results show no significant difference (p>0,05). Operators who had received training were not more likely to make changes than those that had not received training.

6.8 EXPLORATORY ANALYSIS

6.8.1 Correlation between the number of ergonomic problems as per the ergonomic assessment and the number of musculoskeletal disorders (n=48)

The following variables were used when measuring the number of ergonomic problems:

1. Elbow level with middle row of keys 2. Sufficient leg clearance 3. Adjustability of chair 4. Position of mouse 5. Use of a document holder 6. Height of screen 7. Screen positioned in front of operator 8. Telephone positioned in neck 9. Depth of seat pan 10. Lumbar support 11. Feet positioned on the floor

The Spearman Rank Order Correlation test was performed in order to determine whether there was an association between the number of ergonomic problems and the number of musculoskeletal disorders. The results show no significant correlation. (Rs = 0,054936; p = 0,710744)

6.8.2 Correlation between the number of musculoskeletal problems and the number of changes made (n=25, experimental group)

The Spearman Rank Order Correlation test was performed in order to determine whether there was an association between the number of musculoskeletal complaints made by the operator and the number of ergonomic changes made in the workplace. The results show no significant correlation. (Rs = -0,060078; p = 0,775438)

6.8.3 Correlation between the number of ergonomic problems as per the ergonomic assessment and the number of changes made (n=25, experimental group)

The following variables were used when measuring the number of ergonomic problems:

1. Elbow level with middle row of keys 2. Sufficient leg clearance 3. Adjustability of chair 4. Position of mouse 5. Use of a document holder 6. Height of screen 7. Screen positioned in front of operator 8. Telephone positioned in neck 9. Depth of seat pan 10. Lumbar support 11. Feet positioned on the floor

The Spearman Rank Order Correlation test was performed in order to determine whether there was an association between the number of ergonomic problems as per the ergonomic assessment and the number of ergonomic changes made in the workplace. The results show a significant correlation. (Rs = 0,423663; p = 0,034822).

6.8.4 Correlation between the age of the operator and the number of changes made (n=25, experimental group)

The Spearman Rank Order Correlation test was performed in order to determine whether there was an association between the age of the operator and the number of ergonomic changes made in the workplace. The results show no significant correlation.

(Rs = 0,85637; p = 0,683998).

6.8.5 Correlation between the years of experience of the operator and the number of changes made (n=25, experimental group)

The Spearman Rank Order Correlation test was performed in order to determine whether there was an association between the number of years of experience of the operator and the number of ergonomic changes made in the workplace. The results show no significant correlation. (Rs = 0,218644; p = 0,293707).

6.9 MOTIVATION FOR CHANGES IN WORKSTATIONS

TABLE 30 MOTIVATION FOR MAKING CHANGES TO WORKSTATIONS

	Total sample	Experimental group	Control group
Co-incidental changes in work location	9 (18,75%)	2 (8%)	7 (30,44%)
Musculoskeletal pain	3 (6,25%)	–	3 (13,04%)
Training	6 (12,5%)	6 (24%)	–
Training and co-incidental changes in work location	1 (2,08%)	1 (4%)	–
Musculoskeletal pain and training	6 (12,5%)	6 (24%)	–
No intervention	23 (47,92%)	10 (40%)	13 (56,52%)
Total	48 (100%)	25 (100%)	23 (100%)

6.9.1 Discussion in respect of ergonomic changes made to workstations

Reasons for ergonomic changes

The results of the questionnaire show that the control group made the most changes in the workstation due to co-incidental changes (e.g. relocation of workstations or the arbitrary supply of new equipment) in their work location (30,44%) and 13,04% made changes motivated by pain, refer to Table 30.

The highest percentage of changes occurring in the experimental group were due to training (24%) or a combination of pain and training (24%). Only 8% made changes due to co-incidental changes in the workplace or co-incidental changes plus training 4%. (Table 30)

The highest percentage of changes made in the total population, 18,75%, were not within the control of the operator (Table 30). This points to the fact that although operators received training they were not empowered to make those changes and that changes occurred most often when management made a decision to move an operator to another location and not because the operator motivated management to make those work place changes.

The number of changes made: control group versus the experimental group

There was a significant correlation between the number of ergonomic problems as measured by the ergonomic assessment and the number of changes made by the operators who had received training (para 6.8.3).

The results also show no significant difference in the number of changes made by the control group to those made by the experimental group (Table 28) and no association between receiving training and making workstation changes (Table 29).

There was also no correlation found between the number of complaints of musculoskeletal disorders and the number of ergonomic changes made to workstations in the experimental group (para 6.8.2). Age (para 6.8.4) and years of experience (para 6.8.5) also showed no correlation with the number of workplace changes.

6.10 TYPES OF WORKSTATIONS CHANGES

TABLE 31 TYPES OF WORKSTATIONS CHANGES

Types of workstation changes	Number of operators making changes		
	Total sample	Control group	Experimental group
Armrests	1	-	1
Installing blinds	2	1	1
Adjustment of chair	12	3	9
Change of desk	4	2	2
Change in height of screen	9	3	6
Installation of footrest	3	-	3
Installation of document holder	4	3	1
Change in positioning of keyboard	1	-	1
Change in positioning of mouse	1	-	1
Total	37	12	25

The results showed that the most frequent workstation change made by operators was the adjustment of their chair, n=12 (Table 31). This was the easiest change to make (provided that the chair was adjustable) and would have the most beneficial effect. The most amount of adjustability in the workstation is achieved through adjustments to the chair height. Adjusting the chair height will assist in achieving the correct elbow and eye line height.

This was followed by changes in the height of the screen, installation of a document holder and desk changes (Table 31).

Operators were more co-operative in making those changes that they could do themselves without incurring extra costs, e.g. adjusting chair and height of monitor

7 DISCUSSION

7.1 EVALUATION OF THE TRAINING PROGRAM

Initially training programs are evaluated to measure whether a transfer of knowledge has taken place. Thereafter an assessment needs to be conducted to see whether operators are actually practicing what they have learned. If the initial evaluation indicates that learning has taken place but the on-the-job evaluation indicates that operators have not made significant changes in their workstations then this may indicate that the overall management program (e.g. supervisory support, availability of resources, and perceived management commitment) may be lacking or that operators are not motivated enough to make those changes.

The positive results, reflected in Table 22, show a distinct improvement in the ergonomics of the VDT workstation, which was a direct consequence of training as reflected in Table 30. A significant proportion of the operators made better utilization of their workspace and adjusted their workstations where possible without any assistance from management. Fewer changes requiring management approval and capital investment were implemented. The researcher is of the opinion that without the constraints of limited budgets, production pressures and personal factors the positive results would have been further enhanced. It is also surmised that better results would have been achieved if managers had been trained ahead of this study, as this would have further facilitated changes in operator's workstations.

The larger reduction in the mean pain rating of the experimental group versus the control group shows that there was an overall greater decrease in the intensity of the musculoskeletal complaints in the experimental group (Table 10).

Although statistically it was not proven that trained operators were more likely to make changes (Table 29) or to make significantly more changes (Table 28), there was a correlation between the number of ergonomic problems and the number of changes made in the experimental group (para. 6.8.3). This is significant in that it shows that when operators are able to identify more deficiencies in the layout of their workplace they will endeavour to remedy these deficiencies. On that basis alone it is submitted that training programs will assist in reducing or eliminating problems associated with the lack of ergonomic input in the design of VDT workstations.

A further consideration, which has a direct bearing on the results, is that insufficient time was allocated in respect of logistics, for example: there is a lengthy lead-time involved in the requisition, purchasing and installation of equipment. It must be noted that some operators had put in a request for the purchase of new equipment for implementing the necessary changes in their workstations. At the time of the follow-up survey these purchases had yet to be approved and or implemented by management. In a large corporation, such as Warner-Lambert, getting purchasing approval is a lengthy procedure. No single person is responsible for making and implementing a purchasing decision. Budget restrictions also need to be strictly adhered to. It is surmised that if there had been a longer lead-time allocated for the implementation of the program then the percentage of positive changes after intervention would have been higher. To date an additional six new chairs have been purchased for operators in the experimental group as a result of the ergonomic training. As a result of the ergonomic program it is now mandatory that all workstation equipment be ergonomically assessed before being purchased.

The researcher is of the opinion that the time period allowed, from the implementation of the ergonomic changes to completion of the 2nd Questionnaire, was insufficient for the complete resolution of the MSDs. Only through empirical analysis over a meaningful period of time will it be possible to evaluate the degree to which the changes instituted by the VDT operators will result in a reduction in the number and severity of musculoskeletal disorders associated with the use of VDTs.

The "Hawthorne effect" cannot be excluded when comparing the results of the experimental group with that of the control group. The "Hawthorne effect" could have played a part in reducing the difference in the results between the behaviour of the control group vis a vis the experimental group due to the positive attention paid to both the control group and the experimental group.

Included in the training program was information regarding improved work organization. The majority of the operators were unable to make major changes in the organization of their workday due to the fact that they have little control over their work schedules and work in a highly pressurized environment.

Pascarelli et al. (1993) in their study of soft-tissue injuries related to VDT workstations found that ergonomic changes in workstations alone was insufficient in reducing musculoskeletal injuries. They found that in order to attain significant reductions in the number musculoskeletal injuries, attention must also be devoted to improving work methods and organization and reducing stress. A multifaceted approach including physical therapy, technique training and counseling would result in greater improvements in the reduction of MSDs.

Another factor, which could have resulted in a reduction in the difference between the behaviour of the two groups, is the possibility of contamination. All operators were employed at Warner-Lambert, Cape Town and the possibility exists that the two groups could have come into contact with each other and influenced the outcome of the study.

Change in work organization is largely out of the control of most operators and it is therefore recommended that managers receive training in all aspects of ergonomic management as well as introducing methods of reducing stress levels which contribute towards high levels of musculoskeletal disorders. Management needs to ensure that the necessary budget be allocated for the development and implementation of the ergonomic program.

7.2 POSSIBLE REASONS FOR RESISTANCE TO CHANGE

7.2.1 The operator

Operators often throw up major obstacles to change, possibly due to fear, arrogance or ignorance. It is often difficult to convince the employee of the inherent dangers of the operating task when the risk for injury is only over the long-term. It is also difficult to change old habits, "...........this is the way it has always been done".

7.2.2 Management

Management has come under increasing pressure to ensure that the workplace is safe but there are many obstacles in the way of change. Obstacles to change include inertia, self-interest, issues of power and control and other pressures (e.g. deadlines, budget constraints) with ergonomics being low on the list of priorities. These obstacles need to be overcome at all levels of management before improved work practices can be introduced. For operators to make the necessary changes to their workstations they need the support of management to facilitate training and purchase the necessary equipment. The barrier is entrenched employer and employee values and economic interests.

7.2.3 Methology of transference of technology

How is information, obtained through academic research, to be put into practice in the work place? How is the mass of theoretical knowledge to be assessed and assembled in order to make it easily accessible to the workers? We have to find many methods, as no single approach alone will succeed. Pamphlets, fliers, in-house publications and personal demonstrations must augment training programs, which must be reinforced by the Occupational Health Practitioner and the Safety Officer.

Instructors in the workplace must do demonstrations and disseminate information, through written or computerized means. They must adapt the information to match the level of understanding and capabilities of every employee.

8 RECOMMENDATIONS

8.1 WORKSTATION RECOMMENDATIONS

VDT operators are often seated in fixed, awkward positions for long periods of time. This often results in biomechanical stresses of the back, neck, shoulders and upper extremities. Some of these biomechanical stresses imposed on VDT operators can be reduced through careful design and configuration of the workstation (Refer to 4.8 for the Minimum requirements of a video display terminal workstation).

The modifications recommended in the self-help-training course (Appendix 2) are relatively simple and cost-effective involving additional work surfaces or different positioning of the existing desks or luminaries. Adjustability of the VDT workstation components to meet the needs of the individual is paramount and the most practical way of introducing this adjustability is through the chair. Ergonomically designed, easily adjustable, stable chairs are the most important part of any VDT workstation and are more cost effective than purchasing adjustable VDT tables.

A practical way of reducing excessive illumination on source documents is the provision of a document holder. Supporting the document at an angle also provides the correct screen/document relationship. This in turn will improve the back and neck posture, reduce the number of eye movements and visual accommodation necessary to operate a VDT.

8.2 TRAINING PROGRAM RECOMMENDATIONS

The aim of the ergonomic self-help-training program was to improve the ergonomics of VDT workstations thereby improving postural and visual efficiency, resulting in improved comfort and working conditions. Operators of VDTs were empowered, by means of the self-help-training program, to assess their workstations and make ongoing ergonomic changes. Due to their increased awareness of ergonomics in the workplace they would be less tolerant of poorly designed workstations and would therefore be motivate to make the necessary changes in their workstations.

Training results in positive ergonomic changes in the workplace and it is therefore recommended that it be incorporated as part of the induction training for all VDT operators so as to proactively reduce the risk of musculoskeletal disorders. Thereafter reinforcement of the initial training course is recommended with the use of supplementary pamphlets, videos and demonstrations. The introduction of ergonomic issues surrounding VDTs into the safety meetings of the company so that the program can be ongoing and the progress monitored.

Training of all computer technicians so that they can guide prospective users in the correct positioning of their equipment when installing VDTs.

Training of all managers with regards to the standard operating procedure (Appendix 1) so that they will understand the concepts, support the program and assist the ongoing training of the VDT operators. Management must be motivated to allocate a budget to pay for operators to attend training programs and they must be motivated to make the recommended changes when they indicate a positive response.

The results of this research can be used to highlight short falls in VDT workstations and it can also be used as a teaching aid to train other VDT operators.

8.2.1 Why employee education?

The operators could not identify the causes of 20% of MSDs and they were therefore not able to alleviate or reduce their discomfort.

To facilitate the early evaluation and treatment of cumulative trauma disorders (CTDs) all operators should be educated on the causes, early symptoms and signs of CTDs. Educating operators on the benefits of early reporting, timely and appropriate evaluation and treatment will prevent the development of chronic disorders which do not readily respond to treatment and may lead to surgery and possibly permanent disability. Proactive training will encourage employees to report symptoms earlier leading to on the job rehabilitation using a well integrated medical system.

Early, work specific training of operators in good work practices if done proactively will reduce the risk of cumulative trauma disorders and instill good work habits early on in the working life of the operator.

9 CONCLUSIONS

Based on the positive results, it is clear that training programs create an informed awareness as to the nature and risks of inefficient interaction between the worker and the workstation. The training program will in addition aid operators in identifying risk factors for MSDs and eyestrain as well as the means to alleviate (within the parameters of budget constraints and other circumstantial factors) the cause of such symptoms. Positive ergonomic changes will lead to a meaningful reduction in the nature and severity of MSDs and eyestrain as well as preventing or minimizing future MSDs and eyestrain problems.

It is therefore recommended that Warner-Lambert introduce mandatory training for all VDT operators so as to proactively reduce the risk factors for musculoskeletal injuries and eyestrain. Employee education will lead to early reporting and detection of cumulative trauma disorders preventing the development of chronic disorders.

It is concluded that, if implemented, the standards recommended, "Minimum requirements of a video display terminal workstation" (para. 4.8), will over the long term result in improved comfort, reduced muscle tension, reduced visual fatigue and greater productivity.

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SOUTH AFRICAN BUREAU OF STANDARDS

S.A.B.S. 1528: FURNITURE

PART 1: pertaining to seating

PART 2: pertaining to desks/tables and computer stands

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11 APPENDIX 1

<table>
<tr><td colspan="6">WARNER-LAMBERT S.A. (PTY) LTD
SOUTH AFRICA</td></tr>
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PW 1.3.012/0</td></tr>
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OCCUPATIONAL HEALTH NURSING PRACTITIONER</td><td colspan="2">Designation:
SHE MANAGER</td><td colspan="2">Designation:
PRODUCTION MANAGER</td></tr>
</table>

1.0 PURPOSE

1.1 To establish ergonomic criteria for computer workstations in order to minimise the risk of health complaints related to the use of computers.

1.2 To outline the equipment and layout criteria for installation of computer workstations, responsibilities for program implementation and colleague training in computer ergonomics.

2.0 SCOPE

2.1 Applies to all colleagues at Warner-Lambert South Africa who operate computers.

3.0 REFERENCES

N/A

4.0 DEFINITIONS

4.1 Computer Workstations

4.1.1 Computer workstations consist of the various components of a personal computer system, including the central processing unit (CPU) video display terminal, keyboard, mouse, chair and associated furniture.

5.0 RESPONSIBILITY

6.0 Management

5.1.1 Implement recommendations, including capital expenditure for successful intervention and prevention of health complaints related to the use of computers.

5.1.2 Is responsible for the selection, purchase and installation of office furniture meeting the criteria established in terms of this program.

5.1.3 Advise the I.T. and Procurements department in advance of proposed computer equipment or furniture changes.

5.1.4 Develop an approved Capital Expense Request for the computer equipment or furniture necessary to meet this standard.

5.1.5 Provide funds and infrastructure for training of all colleagues who operate a VDT for an average of four or more hours per day and technicians who install VDT's.

5.1.6 Line management should be accountable for ensuring that all operators are given ergonomic train and that they follow the guide lines as set out in Appendix 2.

5.2 Health and Safety Representative

5.2.1 The Health and Safety Representative together with the facility management is to ensure that the same techniques of hazard identification, case documentation, assessment of control options and health care management are used as those directed at any other workplace risks.

5.3 Occupational Health Nursing Practitioner

5.3.1 Provides guidance as is necessary to develop and implement a Medical Care Management Program for the prevention and management of health complaints related to the use of computers.

5.3.2 Evaluation and reporting of occupational injuries resulting from the use of computer workstations

5.3.3 Reporting all suspected work place injuries or diseases to the Department of Labour and the Commissioner for Compensation of Occupational Injuries and Diseases.

5.3.4 Provide training and information to managers, information technologists and colleagues who operate or install computers.

5.3.5 Conduct ergonomic workplace assessments of the workstations of VDT operators.

6.0 PROCEDURE

6.1 Standard Operating Procedure

6.1.1 Ergonomic Program Management

6.1.1.1 Approve financial resources to address ergonomic needs, recognition of potential ergonomic hazards, implementation of control measures, medical case management and training of colleagues.

6.1.2 Ergonomic Hazard Recognition

6.1.2.1 Identify through health complaint questionnaires and workplace hazard assessments potential ergonomic deficiencies related to computer workstations

6.1.2.2 Evaluate reports of potential ergonomic hazards to determine occupational relationship and adequacy of computer workstation layout.

6.1.2.3 For new installations of office equipment, ergonomic issues are to be considered in the selection and installation of equipment and furniture. These issues should include tasks being performed, frequency, duration and repetitiveness of computer use, type and placement of equipment.

6.1.2.4 Originate a Change Control Request (CCR) Form A and forward it to the Change Control Request (CCR) committee for approval.

6.1.3 Ergonomic Hazard Control

6.1.3.1 Based on the information gathered during the ergonomic survey, control measures are to be implemented to address the potential ergonomic hazards and minimise the risk of colleague injury.

6.1.3.2 Engineering controls are to be employed to address ergonomic hazards, this may include positioning of the computer workstation components and the use of furniture and equipment as set out in Appendix A which outlines the ergonomic criteria for computer workstations.

6.1.3.3 Administrative controls, such as job rotation, rest breaks, work practice or other means may be used in conjunction with engineering controls.

6.1.4 Medical Case Management

6.1.4.1 Reported claims of ergonomic related injury are to be assessed to determine occupational relationship.

6.1.4.2 Medical case management is to include evaluation of reported claims, recognition of ergonomic-related injuries, education of job risk factors, medical treatment and follow-up.

6.1.4.3 All suspected work place injuries or diseases must be reported to the Department of Labour and the Commissioner for Compensation of Occupational Injuries and Diseases.

6.1.5 **Colleague Training**

6.1.5.1 Colleagues exposed to risk factors related to the use of computers are to be provided with training and information on the engineering and work practise controls implemented to address ergonomic issues.

6.1.5.2 Colleague training is to be documented.

6.6 Work Instruction

N/A

6.3 Safety, Health and Environmental

N/A

7.0 DOCUMENTATION

7.1 **Forms**

7.2 **Appendices**

Appendix A Ergonomics Criteria for Computer Workstations.

APPENDIX A

ERGONOMIC CRITERIA FOR COMPUTER WORKSTATIONS

Video Display Terminals

Top of screen at eye level and tilted slightly backwards.

Document holder at same distance from eyes as VDT.

Positioned perpendicular to windows and other light sources.

Screen should be located at arms length or further away from the user.

Keyboard/Mouse

Adjustable for height and angle.

Positioned at a height that keeps wrists straight.

Mouse positioned next to and on the same level as the keyboard

Chair

Chair should have a height adjustment mechanism adjustable from a seated position.

Seat cushion should have a rounded front.

Chair should have an adjustment lumbar support.

Chair should be five-foot swivel type.

Body position

Arms and elbows at 90 degree angle.

Feet flat on the floor with lower legs at a 90 degree angle to the thigh (footrest should be used when necessary).

Eye level with or slightly above the top of the screen.

Wrist straight supported by wrist rest if necessary.

Lighting

Overhead lighting should be screened and not contribute to glare on the screen.

Work routine

Alternate work should be performed every two hours for a minimum of fifteen minutes.

Frequent micro-breaks.

12 APPENDIX 2

ERGONOMIC TRAINING FOR VDT OPERATORS

The operation of a Video Display Terminal for prolonged periods of time has resulted in exposure to risks related to the:

Visual system

Causes: poor light distribution

incorrect positioning of equipment

poor legibility of screen display

Results: visual fatigue e.g. impairment of vision, sore eyes

Musculoskeletal systems

Causes: prolonged sitting in an awkward fixed position

repetitive movements of the head, body or arms

Results: musculoskeletal disorders of the neck, shoulders, arms or back

Nervous system

Causes: poor job organization

high-speed repetitive work

lack of control over work

Results: Fatigue and stress

The effects of poor ergonomics include:

- Reduced concentration
- Discomfort
- Fatigue

Theses could lead to:

- reduced productivity
- errors
- accidents
- work related cumulative trauma disorders

HOW TO REDUCE EYESTRAIN AND POSTURAL STRESS

BY IMPROVING YOUR VIEW OF THE SCREEN

- adjust light setting to improve the contrast of the characters with the background
- screen and keyboard should be positioned directly in front of operator at least an arms length away from the operator
- screen should be tilted slightly backwards
- top screen should be level with or slightly lower than eye line
- line of vision should be parallel to light sources

- shading of light sources to reduce glare/reflections
- screen filters should be used to decrease glare when other methods of reducing glare have not been successful
- back of screen should face center of room
- dust screen regularly

WORK SURFACE

- the work surface should be able to accommodate the tasks being performed, there should be sufficient space for the keyboard, screen, writing paper and documents etc.

KEYBOARDS

- keyboard should be 6cm away from the edge of the desk (space to rest wrists during typing pauses)
- positioned at a height that keeps wrists straight
- arms should rest against your side, with elbows as cold to the body as possible and shoulders relaxed
- it can be positioned flat or angled slightly upwards at the back so that the keys can be reached whilst keeping the wrists straight
- keys should be slightly concave on top to conform to the shape of the fingers

- keyboards should be operable with a light touch as excessive force can lead to cumulative trauma disorders

ARMRESTS

- armrests are optional and depend on preference and tasks performed, they should not restrict movement or impede the worker's ability to get close enough to the work surface and arms should not rest on the armrest whilst typing
- elbow rests should be correctly positioned so as to support the weight of the arms with the lower arms parallel to the work surface level with the home row of the keyboard

CHAIR

- operators should use an ergonomically designed chair:
  - fully adjustable for height of seat pan and backrest
  - it should support the lumbar area
  - swivel on five castors
  - the front edge of the seat pan should be rounded to avoid cutting into thighs
  - it should be stable and support the operator reducing static muscle tension
  - it should be padded just enough to reduce pressure on the buttocks

- demonstration on how to adjust operators chair
- adjust seat so that your elbows are at the same height as the middle of your keyboard
- use a foot rest if your feet do not reach the floor, feet resting on the floor or a footrest with the legs at a 90 degree angle prevents pressure on the under thighs and allows for stabilization of the posture
- sit well back in the chair and allow it to support the natural curve of the spine in the lower back
- posture: head should be over the shoulders, back should be upright against the back of the chair

MOUSE

- the mouse should be on the same level as keyboard
- it should be placed directly next to the keyboard in the "immediate-reach zone"
- wrist should always be in neutral position
- never use force when dragging or clicking the mouse, use the whole arm instead of just the forearm reducing strain on the hand and wrist

WORK SURFACES

- there should be sufficient space under the work surface to accommodate legs and postural changes

- the surface area should be big enough to allow space for computer related equipment, paper, books and other materials needed
- leg area under the work surface should be at least 80cm wide to allow for unobstructed turning and at least 70cm deep to allow for postural change
- the edge of the work surface should be rounded and not sharp to prevent pressure on the wrists

ADDITIONAL ERGONOMIC INTERVENTIONS

- use of a document holder placed at the same distance from the eyes as the screen and at the same height
- wrist rests can be used to support the wrists in the pauses between typing, they should be rounded, providing a firm but soft cushion

WORK ROUTINE

- alternate screen-based and non screen-based work
- rest breaks: short and frequent, taken before fatigue sets in
- multitasking: often the keyboard is used in conjunction with other instruments e.g. telephone. The use of a telephone headset if multitasking cannot be avoided.

13 APPENDIX 3

QUESTIONNAIRE FOR COMPUTER USERS

Full name:................................ Age:...... Department:................Ext.No.....
What is your job title:?..................

1. Do you use a computer as part of your job description? Yes/No

2. If **yes,** an average of how many hours a day are spent using the computer?.........

3. How long have you been working with a computer?............

4. Are you able to touch type? Yes/No

5. Do you suffer from rheumatoid or thyroid problems? Yes/No

6. Do you encounter any difficulties whilst operating your computer? Yes/No
   If **yes,** describe any difficulties or problems that you experience.

....

7. Do you ever find it difficult to read from the screen? Yes/No
   Why is this?...

8. Do you have problems with reflections on your screen. Yes/No

9. Do you suffer from eyestrain whilst working at the computer (i.e. blurred vision, dry eyes, headaches). Yes/No

10. Are you satisfied with the layout of your working space? Yes/No
    If **no,** what is causing your dissatisfaction?.......................................

    ....

11. Are you satisfied with your chair? Yes/No
    If **no,** what is causing your dissatisfaction?..

    ....

12. Can you set your own work pace? Yes/No

13. Do you feel pressurized by your work? Yes/No

SYMPTOM SURVEY

1. Have you had any NECK TROUBLE during the last 3 months? Yes/No

(By "neck problems" is meant ache, pain or discomfort).

If **yes,** please complete the following questions, if **no** go to question 2.

(Please circle either yes or no where applicable)

For how long have had this problem with your neck?.................

Have you ever hurt your neck in an accident? Yes/No

What do you think caused the problem?..

....

What is the total length of time that neck trouble has prevented you from doing your normal work during the past 3 months? ....

How many days have you been absent from work due to neck problems in the past 3 months?...................................

Have you had any treatment for the neck problem during the past 3 months? Yes/No

If **yes,** what type of treatment?...

How would you rate the severity of your neck problem (**circle** the number that denotes the severity of your pain)?

1_____2_____3_____4_____5_____6_____7_____8_____9_____10

None **Unbearable**

2. Have you had any BACK TROUBLE during the three months? Yes/No

(By "back problems" is meant ache, pain or discomfort).

If **yes,** please complete the following questions, if **no** go to question 3.

(Please circle either yes or no where applicable)

For how long have you had this problem with your back?..................

Have you ever hurt your back in an accident? Yes/No

What do you think caused the problem?...

....

What is the total length of time that back trouble has prevented you from doing your normal work during the past 3 months?..

How many days have you been absent from work due to back problems in the past 3 months ?...................................

Have you had any treatment for your back problem during the past 3 months? Yes/No

If **yes,** what type of treatment?...

How would you rate the severity your back problem (**circle** the number that denotes the severity of your pain)?

1_____2_____3_____4_____5_____6_____7_____8_____9_____10

None **Unbearable**

3. Have you had any SHOULDER TROUBLE during the last 3 months? Yes/No

(By "shoulder problems" is meant ache, pain or discomfort).

If **yes,** please complete the following questions, if **no** go to question 4.

Do you have problems with your: - right shoulder/left shoulder/both shoulders. **(Circle correct answer).**

(Please circle either yes or no where applicable)

For how long have you had this problem with your shoulder/s?.....................

Have you ever hurt your shoulder/s in an accident? Yes/No

What do you think caused the problem with your shoulder/s?............................

....

What is the total length of time that shoulder trouble has prevented you from doing your normal work during the past 3 months? ....

How many days have you been absent from work due to shoulder problems in the past 3 months?..................................

Have you had treatment for the shoulder problem during the past 3 months? Yes/No

If **yes,** what type of treatment?..

How would you rate the severity of your shoulder problem (**circle** the number that denotes the severity of your pain)?

1_____2_____3_____4_____5_____6_____7_____8_____9_____10

None **Unbearable**

4. Have you had any ELBOW TROUBLE during the last 3 months? Yes/No

(By "elbow problems" is meant ache, pain or discomfort).

If **yes, please** complete the following questions, if **no** go to question 5.

Do you have problems with your: - right elbow/left elbow/both elbows **(Circle the correct answer)**

(Please circle either yes or no)

For how long have you had this problem with your elbow/s?..................

Have you ever hurt your elbow/s in an accident? Yes/No

What do you think caused the problem?.......................................

....

What is the total length of time that elbow trouble has prevented you from doing your normal work during the past 3 months? **..**

How many days have you been absent from work due to elbow problems in the past 3 months?**...................................**

Have you had treatment for the elbow problem during the past 3 months? Yes/No

If **yes,** what type of treatment?..

How would you rate the severity your elbow problem (**circle** the number that denotes the severity of your pain)?

1______2______3______4______5______6______7______8______9______10

None **Unbearable**

5. Have you had any WRIST TROUBLE during the last 3 months? Yes/No

(By "wrist problems" is meant ache, pain or discomfort).

If **yes,** please complete the following questions, if **no** you have completed questionnaire.

Do you have problems with your:

- right wrist/left wrist/both wrists **(Circle the correct answer)**

(Please circle either yes or no)

For how long have you had this problem with your wrist/s?........................

Have you ever hurt your wrist/s in an accident? Yes/No

What do you think caused the problem?..

....

What is the total length of time that wrist trouble has prevented you from doing your normal work during the past 3 months? ....

How many days have you been absent from work due to wrist problems in the past 3 months?..................................

Have you had treatment for the wrist problem during the past 3 months? Yes/No

If **yes,** what type of treatment?...

How would you rate the severity your wrist problem (**circle** the number that denotes the severity of your pain)?

1______2______3______4______5______6______7______8______9______10

None **Unbearable**

14 APPENDIX 4

FOLLOW-UP QUESTIONNAIRE **Full name:………………………………..**

(Circle yes or no)

1. Have you suffered from eyestrain in the past 3 months (e.g. blurred, dry eyes, headaches)? Yes/No
2. Do you have problems with reflections on your computer screen? Yes/No
3. Do you encounter difficulties whilst operating your computer? Yes/No
4. Have you made any changes to your workstation in the past 3 months? Yes/No
5. If **yes,** what changes have you made?……………………………………

   ………………………………………………………………………………

   ………………………………………………………………………………

   ………………………………………………………………………………
6. What motivated you to make the changes? ………………………………

   ………………………………………………………………………………
7. Are you satisfied with the layout of your working space? Yes/No

SYMPTOM SURVEY (Follow-up questionnaire)

1. Have you had any neck trouble during the past 3 months? Yes/No

If **no** go to question 2, if **yes** how would you rate the severity of your neck problem (**circle** the number that denotes the severity of your pain)?

1______2______3______4______5______6______7______8______9______10

None **Unbearable**

What is the total length of time that neck trouble has prevented you from doing your normal work during the past 3 months?...

How many days have you been absent from work due to neck problems in the past 3 months?...................

Have you had any treatment for the neck problem during the past 3 months? Yes/No

If **yes,** what type of treatment?..

2. Have you had any back trouble during the past 3 months? Yes/No

If **no** go to question 3, if **yes** how would you rate the severity of your back problem (**circle** the number that denotes the severity of your pain)?

1______2______3______4______5______6______7______8______9______10

None **Unbearable**

What is the total length of time that back trouble has prevented you from doing your normal work during the past 3 months?..

How many days have you been absent from work due to back problems in the past 3 months?...................

Have you had any treatment for the back problem during the past 3 months? Yes/No

If **yes,** what type of treatment?...

3. Have you had any shoulder trouble during the past 3 months? Yes/No

If **no,** go to question 4, if **yes** how would you rate the severity of your shoulder problem (**circle** the number that denotes the severity of your pain)?

1_____2_____3_____4_____5_____6_____7_____8_____9_____10

None **Unbearable**

What is the total length of time that shoulder trouble has prevented you from doing your normal work during the past 3 months?..

How many days have you been absent from work due to shoulder problems in the past 3 months?...................

Have you had any treatment for the shoulder problem during the past 3 months? Yes/No

If **yes,** what type of treatment?..

4. Have you had any elbow trouble during the past 3 months? Yes/No

If **no,** go to question 5, if **yes** how would you rate the severity of your elbow problem (**circle** the number that denotes the severity of your pain)?

1______2______3______4______5______6______7______8______9______10

None **Unbearable**

What is the total length of time that elbow trouble has prevented you from doing your normal work during the past 3 months?..

How many days have you been absent from work due to elbow problems in the past 3 months?..................

Have you had any treatment for the elbow problem during the past 3 months? Yes/No

If **yes,** what type of treatment?...

5. Have you had any wrist trouble during the past 3 months? Yes/No

If **no,** you have completed questionnaire, if **yes** how would you rate the severity of your wrist problem (**circle** the number that denotes the severity of your pain)?

1______2______3______4______5______6______7______8______9______10

None **Unbearable**

What is the total length of time that wrist trouble has prevented you from doing your normal work during the past 3 months?...

How many days have you been absent from work due to wrist problems in the past 3 months?...................

Have you had any treatment for the wrist problem during the past 3 months? Yes/No

If **yes,** what type of treatment?...

15 APPENDIX 5

ERGONOMIC CHECKLIST FOR VDT OPERATORS

Adapted from "Visual Display Terminals" by Cakir et al. (1980), published by John Wiley & Sons and Work with Display Screen Equipment, Proposals for Regulations and guidance, a consultative document issued by the Health and Safety Commission, under Sect 50(3) of the Health and Safety at Work etc Act 1974.

Screen

Height Adjustable Yes/No

Does screen tilt? Yes/No Does screen swivel? Yes/No

Distance from operator............

Distance of eye-line above or below the top of the screen...........

Distance between the back of the computer and the wall behind it ....

Keyboard

Adjustable

Height Yes/No

Split key board Yes/No

Distance of elbows above or below keyboard...........

Work surface

Height……………… Leg clearance (floor to work surface) …………..

Width………………

Length………………

Sharp edge Yes/No

Sufficient space allocated for change of posture Yes/No

Is leg area at least 80cm to allow for unobstructed turning Yes/No

Is leg area at least 70cm deep………………..Yes/No

Chair

Height of seat adjustable Yes/No From sitting position Yes/No

Good lumbar support Yes/No

Adjustable for height of lumbar support Yes/No

Seat pan height from the floor…………

Seat width…………..

Seat depth…………..

Is the front edge rounded to avoid cutting into thighs Yes/No

Arm rests Yes/No Are they adjustable Yes/No

Distance from the top of lumbar support to seat pan………………

Is the chair stable? Yes/No Does is have a five point base? Yes/No

Does the chair have castors? Yes/No

Foot rest Yes/No Adjustable? Yes/No

Lighting

Indirect glare sources in the operators field of vision, lights windows, etc?

....

Are light sources fitted with glare shields?.................................

Are the VDT workplaces positioned such that the operators line of vision is

-parallel to luminaries?.................

-parallel to windows?....................

Are the windows fitted with blinds?...........................

General Document holder, type and position...........................

Obstructions under desk Yes/No

Use of corrective appliances e.g. glasses, wrist supports...............................

Working posture adapted by operator

Twisting of neck and trunk to view screen Yes/No

Position of screen in relationship to operator...............................

Position of keyboard in relationship to operator...........................

Wrist posture (extension, flexion or ulnar and radial deviation)....................

Upper arms vertical.....................

Lower arms horizontal.....................

Shoulder posture..................................

Position of feet..................................

Positioning of telephone during conversation..............